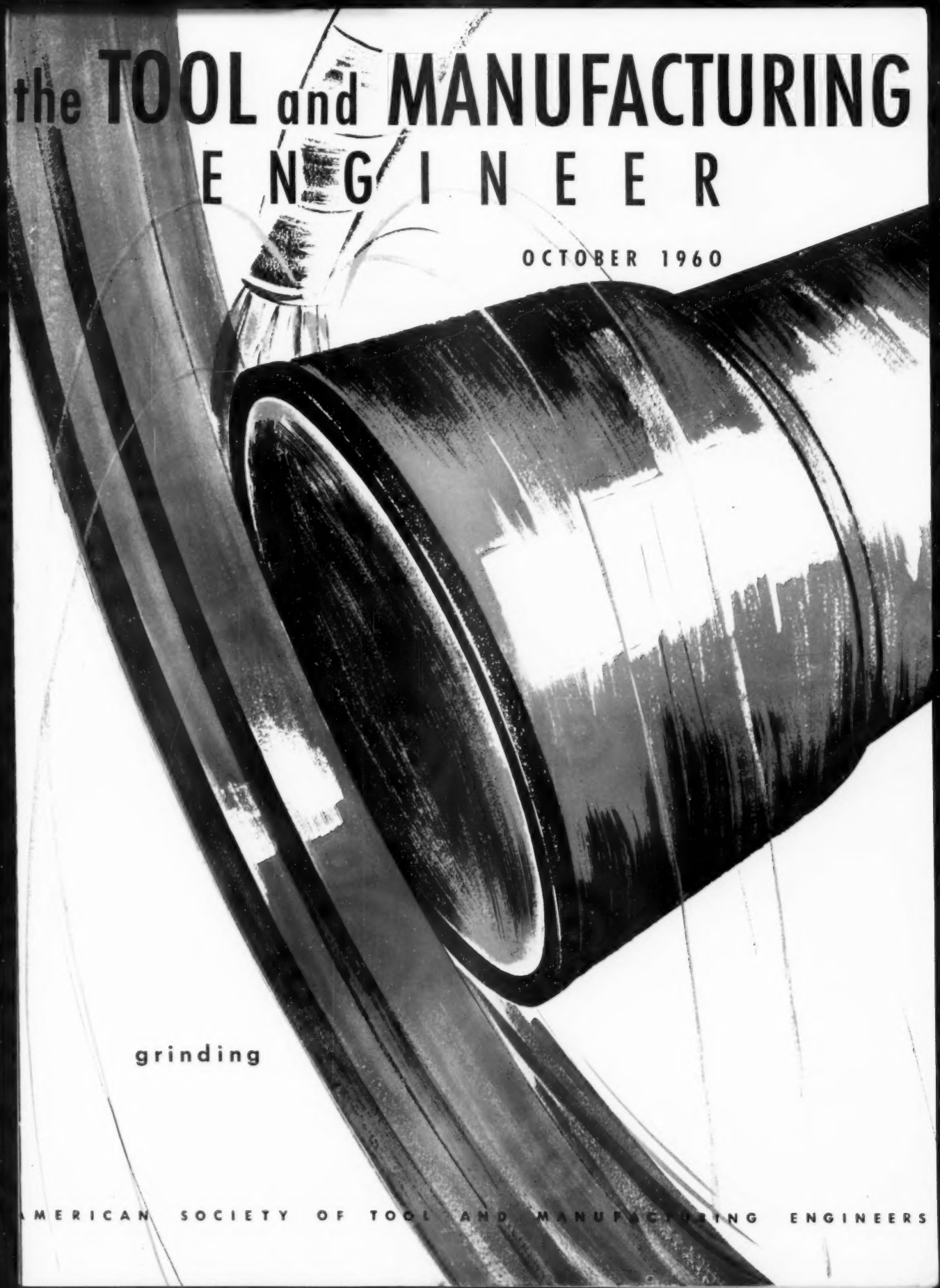
the TOOL and MANUFACTURING ENGINEER

OCTOBER 1960



grinding

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Did you see Heald's NEW Model 171A Internal?

It's **LOADED** with new features for better production and easier servicing!

1. **Cross-slide Wheelhead Feed** assures maximum freedom from distortion under heavy roughing cuts—feeds faster and more accurately, with better size control.
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3. **Infinitely Variable Compensation** for wheel wear, from 0 to .004", contributes to more constant size and longer wheel life.
4. **Front-Adjusted Wheel Dresser** is easier and safer to operate.
5. **Hydraulic Workhead Drive** provides greater range of speeds (from 50 to 1350 rpm) at the turn of a knob.
6. **Machine Base Contains No Heat-Producing Equipment** —hydraulic power and lube oil units are externally mounted, preventing thermal distortion and permitting easier access for servicing. Variable-displacement hydraulic system pumps oil only when it is *needed* to operate a cylinder or motor.
7. **Hydraulic and Electrical Cabinet** contains all hydraulic and electrical control mechanisms in separate dust-tight compartments—everything is easier to get at. Faster-acting miniature d-c solenoid valves speed-up cycles, last longer.
8. **Large Cabinet-Type Guards** cover entire work area and open automatically for greater safety, better coolant control and easier access for fixture changeover.

Heald Model 171A Internal Grinders are available in Size-Matic, Gage-Matic or Plain models for work with up to 8" swing and angular capacity up to 90°.

Ask your Heald engineer for complete information, or send for your copy of Bulletin No. 2-171A-1.

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HEALD

the TOOL and MANUFACTURING ENGINEER

Volume 45
No. 4

October
1960

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With today's tighter tolerances, product designers, manufacturing engineers and metrologists must learn to speak the same language.

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THIS MONTH'S COVER

The speed and accuracy of modern grinding machines and grinding wheels is suggested by this view of a diamond wheel performing a finishing operation on a tungsten carbide ring at General Electric's Metallurgical Products Dept. in Detroit. The majority of the readers of this magazine are intensely interested in grinding, so they will find the article on a wheel test program (page 83) and the article on correcting wheel unbalance (page 95) especially significant.

THE TOOL AND MANUFACTURING ENGINEER is regularly indexed in the *Engineering Index Service* and *Applied Science & Technology Index*, used generally in libraries. The magazine is available in microfilm form at nominal cost.

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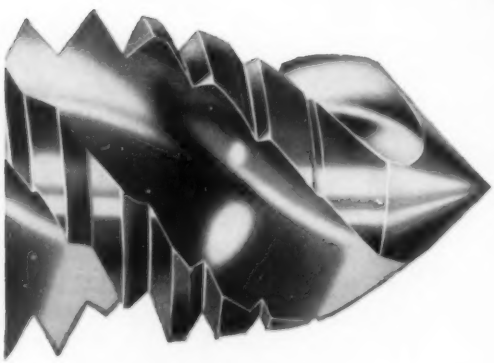

RUGGED STRENGTH . . . SHEARING CUT . . . MORE THOROUGH CHIP REMOVAL

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What Incentives Work?

Over-all costs and quality of a product are vitally affected by morale and attitude as well as ability of a worker. Although usually not involved directly with the worker, the tool and manufacturing engineer must be familiar with all factors of productivity so he can intelligently apply engineering experience. His responsibility is to provide the best and most economical production methods possible.

Many machine operators and assemblers are convinced that standard incentives are no longer practical because they do not always accomplish the purposes for which they were intended. Instead they may involve excessive administrative costs, require the wisdom of Solomon for application, encourage endless discussions over trivia, foster cheating and petty acts, and necessitate policing of inspection and timecards.

Needless to say, some workers feel that the price of honesty is high and that the mediocre worker benefits at the expense of the productive worker when standard time is used, to say nothing of high nonproductive costs of administration and overhead. These same workers are seriously studying other systems of pay and are asking the question, "what is wrong with profit sharing?" It has worked well with other groups and could be even more effective with production workers. This argument appears valid, particularly with workers having many years of continuous service within the same company. Certainly their investment in that company is tremendous, testifying to a basic loyalty which is an essential ingredient of a successful profit-sharing plan.

Already one well-known and established midwestern manufacturer has a group of employees that have organized for this purpose. Indications are also that management may add its blessings. Whatever the incentives, the effects upon productivity must be recognized and understood.

John W Greve

EDITOR

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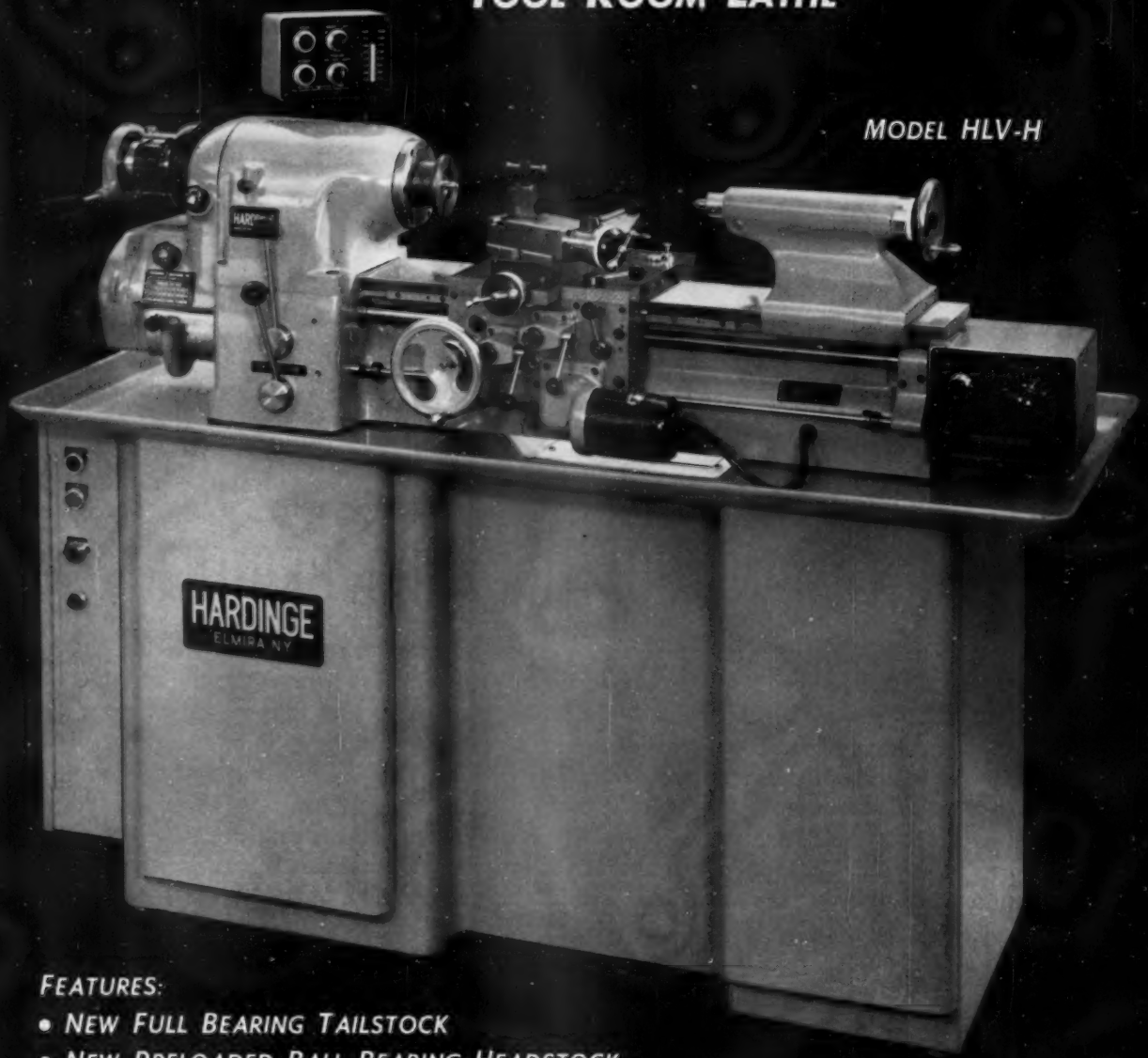

FEATURES:

- NEW FULL BEARING TAILSTOCK
- NEW PRELOADED BALL BEARING HEADSTOCK
- NEW ELECTRIC INTERLOCK FOR SPINDLE LOCK PIN
- NEW WIDER FULL BEARING HARDENED AND GROUND DOVETAIL BEDWAYS

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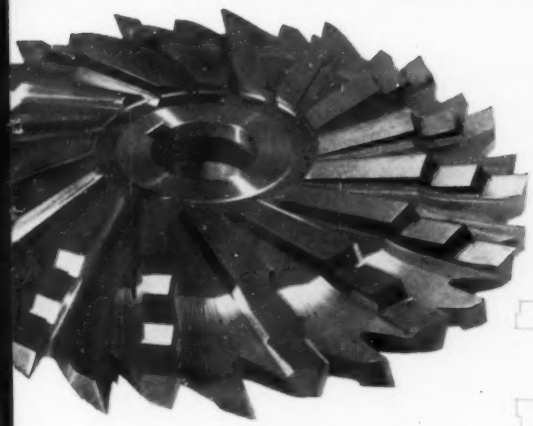
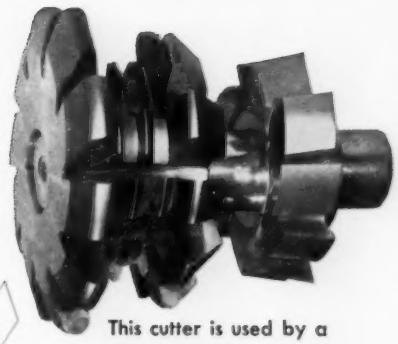


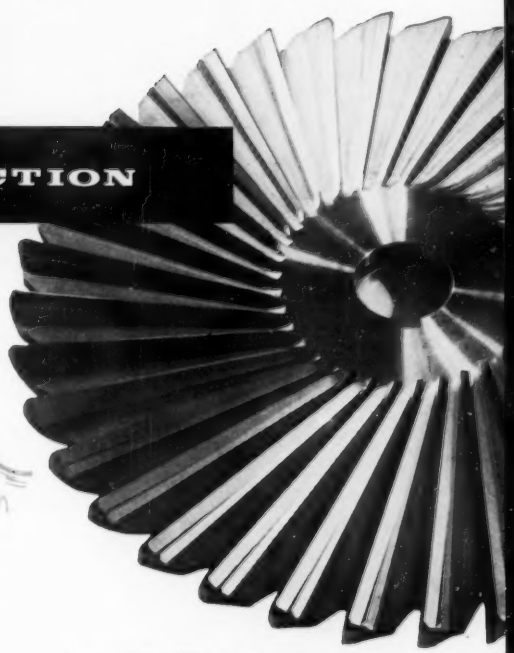
A special multiple-step milling cutter used by steam turbine manufacturer to cut stepped rotor slots for turbine blades.



This cutter is used by a prominent saw manufacturer to form mill the profile in dado blade sets for the wood working industry.

HOW TO GET THE MOST OUT OF HIGH SPEED PRODUCTION MILLING MACHINES

This tapered multiple thread mill cuts threads in pipe joints used in oil well drilling operations.



A special milling cutter for sweep milling impellers used in air conditioning and jet engine sections.

Illinite® Special Milling Cutters, like those shown here, speed production and cut costs two ways:

(a) Illinois Tool applied metallurgy assures long, efficient tool life through proper material selection, forging and heat treatment *tailored to your specific application.*

(b) Illinois Tool engineering job-tailors your special milling cutters for maximum efficiency. ITW tool designers often combine several machining operations into a single cutter or gang, with consequent savings of considerable time per piece. Specially designed tools such as these also assure improved accuracy *since accuracy is designed into the tool,* and is not dependent upon several separate operations.

Why not get the most from *your* high speed production machines. Ask your Illinite distributor about job-tailored milling cutters today! Remember, he also carries a complete stock of standard cutters for prompt delivery.

Write today for this helpful new booklet on Metallurgy in Tool Design and Production.

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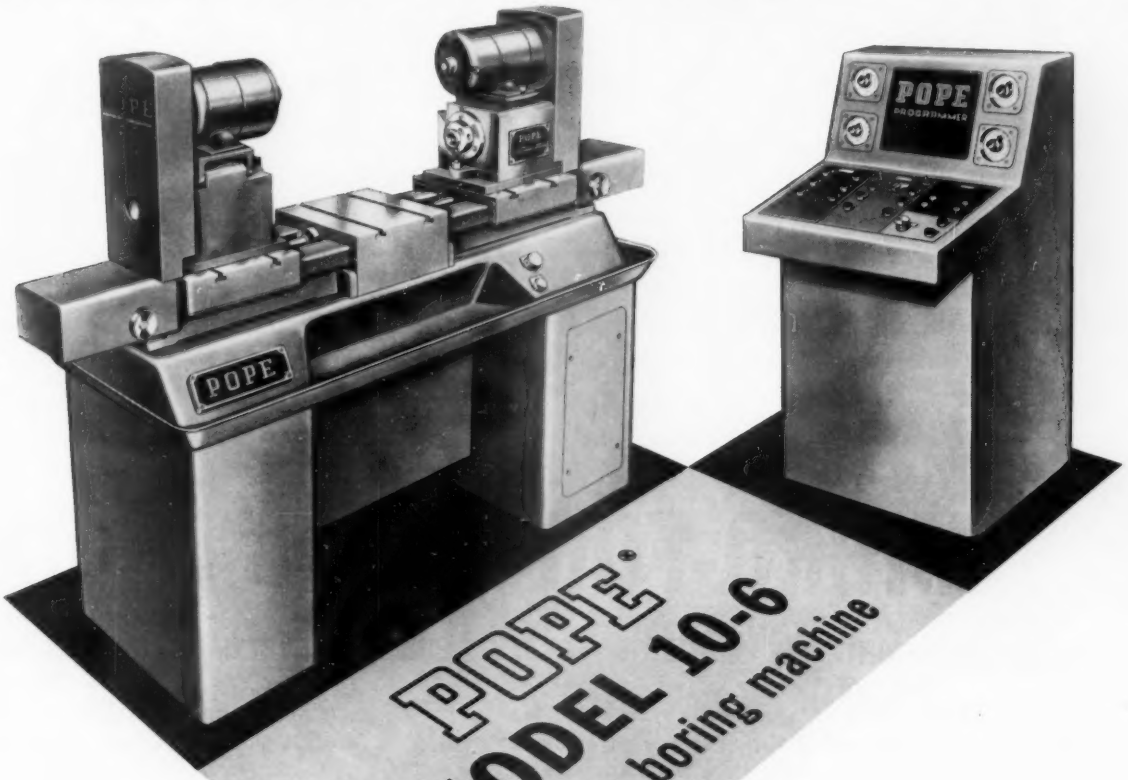

- Table dimensions — 12" x 12"
- Maximum stroke, each head — 6"
- Standard center height — 5½" (variable)

Here are some of its advantages:

Two Heads Are Better Than One. Two Horizontal Boring Heads moving from both directions simultaneously over a stationary work table increase your production. *Two heads working are more profitable than one.*

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New Pope Electric Programmer is a unified, separate console containing all the electric controls for fast operation; duplicate set-ups can be made quickly.

These and other exclusive features put this Precision Double End Boring Machine way out front for production, precision and profit. *Ask for Bulletin No. S-21.*

No. 131

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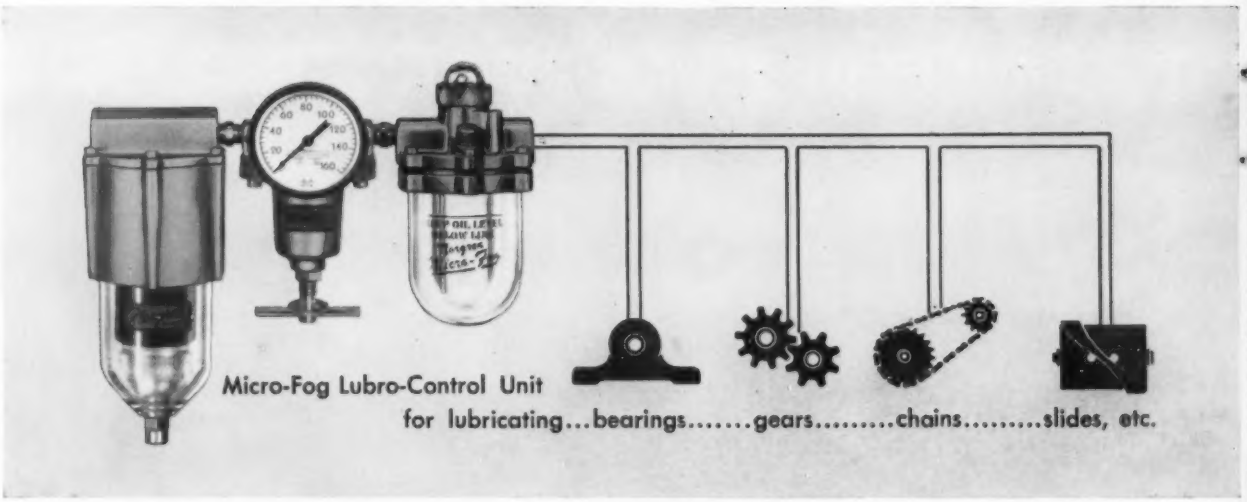


Norgren MICRO-FOG LUBRICATION

Automatically lubricates every bearing surface on a machine

About 10 years ago, a new type of oil fog lubrication, called Micro-Fog was marketed by the C. A. Norgren Co. More and more machine tools are being completely lubricated with Micro-Fog—all bearings, gears, chains, slides, ways.

With any method of lubrication, the only oil that actually lubricates is the thin film that separates the bearing surfaces. Any additional lubricant is a waste and may even be harmful, causing overheating through fluid friction.

An air-borne fog of extremely small oil particles is created by a Norgren Micro-Fog Unit. This Norgren Micro-Fog can be conveyed long distances through low pressure pipelines directly to the bearing surfaces.

Micro-Fog provides thorough lubrication

At the bearing surfaces a nozzle-like fitting, called a reclassifier, causes the small dry oil particles to combine into larger wet particles. These impinge upon the bearing surfaces and cover them thoroughly and continuously with a protective film of oil.

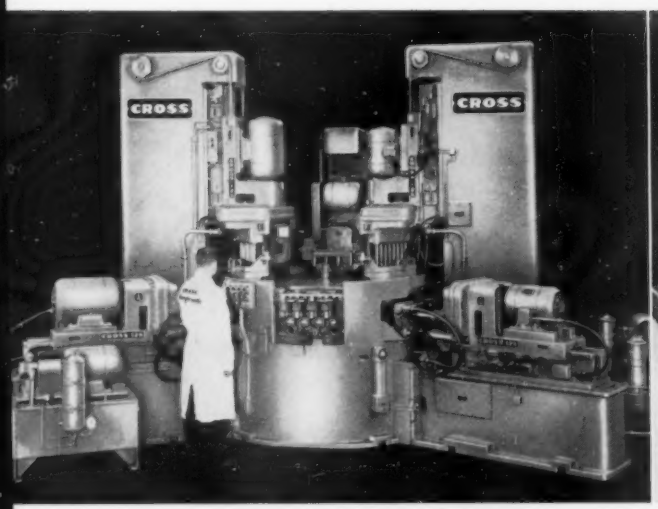
A Norgren Micro-Fog Lubro-Control Unit is a combination of three Norgren Units—an air line filter to remove the compressed air contaminants, a pressure regulator to accurately control pressure and a Micro-Fog Lubricator.

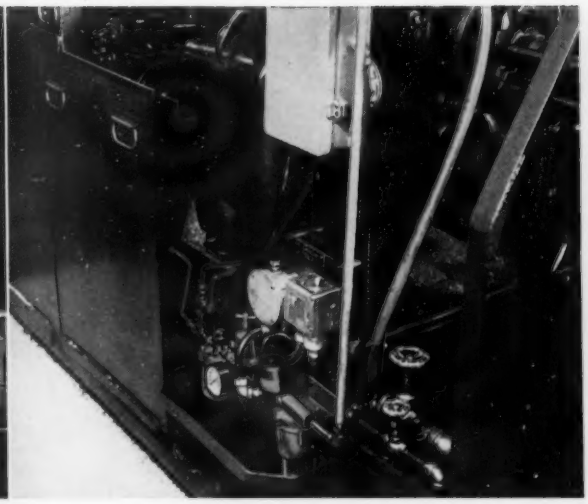
Norgren Lubro-Control Units are adjustable to deliver automatically just the right amount of Micro-Fog to provide continuous lubrication.

A few of the benefits provided by Micro-Fog:

Longer bearing life. Reduced downtime, maintenance and bearing replacement costs. Lower bearing temperatures. Less lubricant used—lower lubricant costs. Centralized lubrication, eliminating time-consuming hit and miss methods. No excess of lubricant—minimum product contamination and easier housekeeping.

Today, Micro-Fog Lubro-Control Units are operating successfully on practically all types of equipment. These applications range from high-speed precision grinders, running at 450,000 rpm, to huge rolling mill bearings on shafts as large as 34″ in diameter and turning at relatively slow speeds.



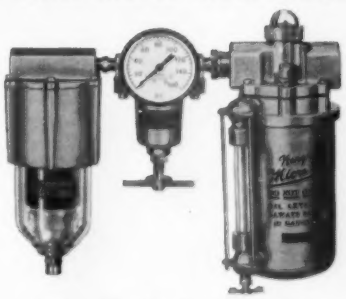


The 150 ball bearings and 70 spur gears on this machine are lubricated by a single Norgren Micro-Fog Lubro-Control Unit. Results: 1. Bearing and gear box seals eliminated. 2. Oil leakage of lubrication system eliminated and safer floor conditions around machine. 3. Oil usage greatly reduced.

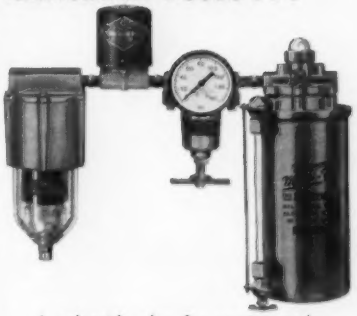
With Norgren Micro-Fog, ½ pint of oil per day does a better job of lubrication than the 15 gallons of oil used per day with the previous circulating system. On this automatic screw machine, the Norgren Micro-Fog Unit lubricates sleeve bearings, anti-friction bearings, slide blocks, guides, chucking mechanism and gears.

Wide selection of Norgren Units meets most machine lubrication needs . . .

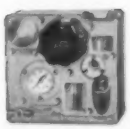
Small, compact units for use where space is tight.



A Norgren Lubro-Control Unit can be made up of any combination of Norgren filter, regulator, lubricator.

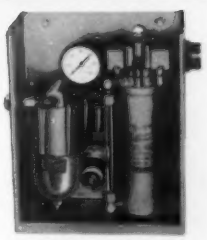


A solenoid valve for starting and stopping lubrication as machine is turned on and off can be incorporated as part of a Lubro-Control Unit.



This Lubro-Control Unit is small, compact and complete with filter, regulator and lubricator. It measures only 6 1/32" x 6 1/32" x 5 3/16".

Compact and complete, this Norgren Unit includes automatic alarm controls that safeguard the machine against lubrication failure.



This cabinet unit can be entirely enclosed and locked. It is compact and complete and is equipped with automatic alarm controls.

The above is only a partial listing of the complete Norgren line. For complete information on the large selection of Norgren Micro-Fog Lubro-Control Units available, WRITE FOR DESCRIPTIVE LITERATURE

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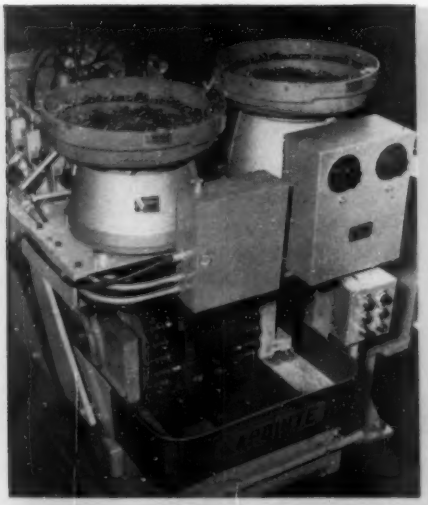
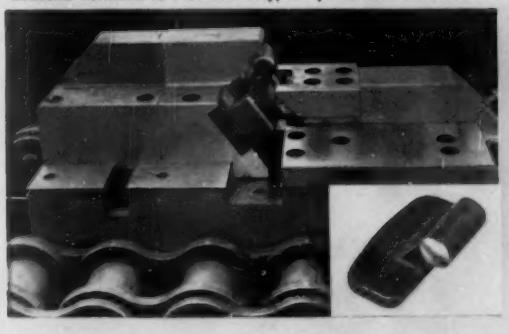


Production rates up to 3200 parts per hour are maintained day in and day out on this hopper-fed Lapointe Continuous-Broaching Machine, 10-ton, 42-inch stroke.

MANUAL LOADING is fast and easy, for parts such as these.



these pictures tell the story of

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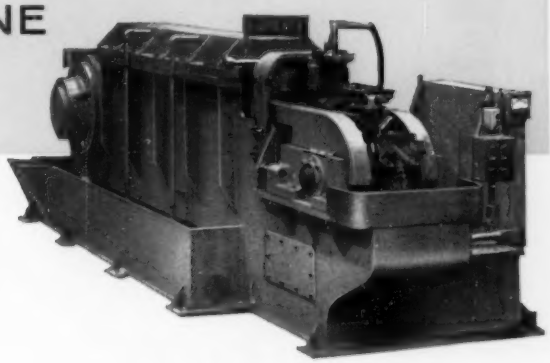

This is the machine that doesn't stop! Ruggedly built, and with powerful, heavy-duty twin drive chains, this Lapointe Continuous Broaching Machine comes in five standard sizes: 10 to 60 HP, 40 to 160-inch stroke. Any desired combination of horsepower and stroke can be obtained.

All fixtures are designed with automatic clamping and provide self-ejecting of parts.

Easy loading eliminates strain, prevents operator fatigue.

Carbide tooling can be used wherever required.

In important plants everywhere, Lapointe Continuous-Broaching is eliminating production bottlenecks and driving down manufacturing costs. Small parts are broached for business machines, cameras, computers . . . larger, heavier parts are broached for automotive and other industrial applications.

All the guesswork's gone, when you surface-broach your repetitive contours and flats on the Lapointe Continuous-Broaching Machine.

You *know* you will get • tremendous production, even on tough forged blanks • dimensional accuracy to exacting tolerances • remarkable surface finish • low unit cost.

Perhaps Lapointe Continuous-Broaching can solve one of your production problems. You can find out very easily, by dropping us a line!

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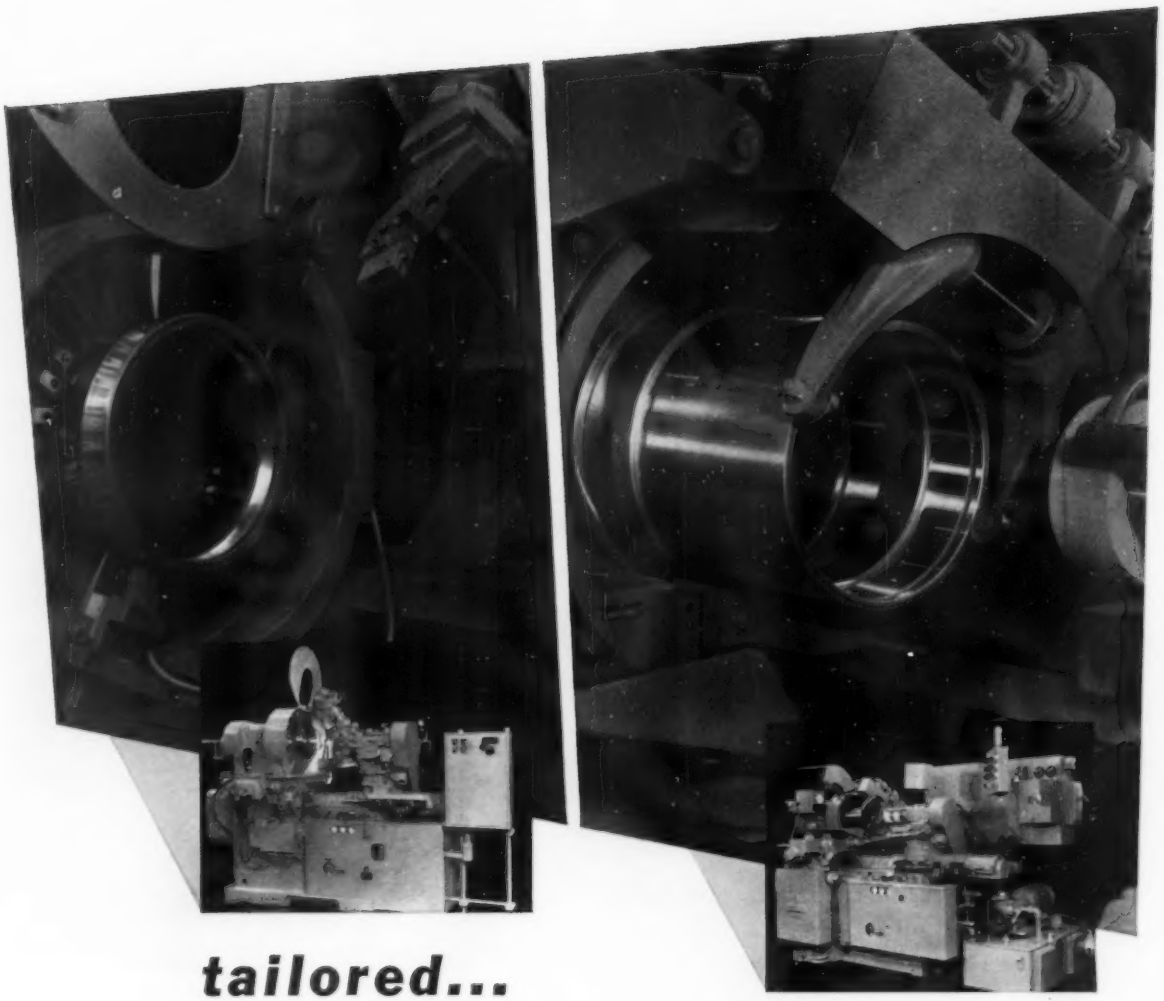

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Whether you are grinding a range of bearing races involving one shape in various sizes, or parts which involve a complete change in configuration — for example, from roller bearings to ball tracks — the versatility and tailored tooling of Bryant Internal Grinders assure you of record production rates and consistently high quality.

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PRODUCTION POINTERS from GISHOLT

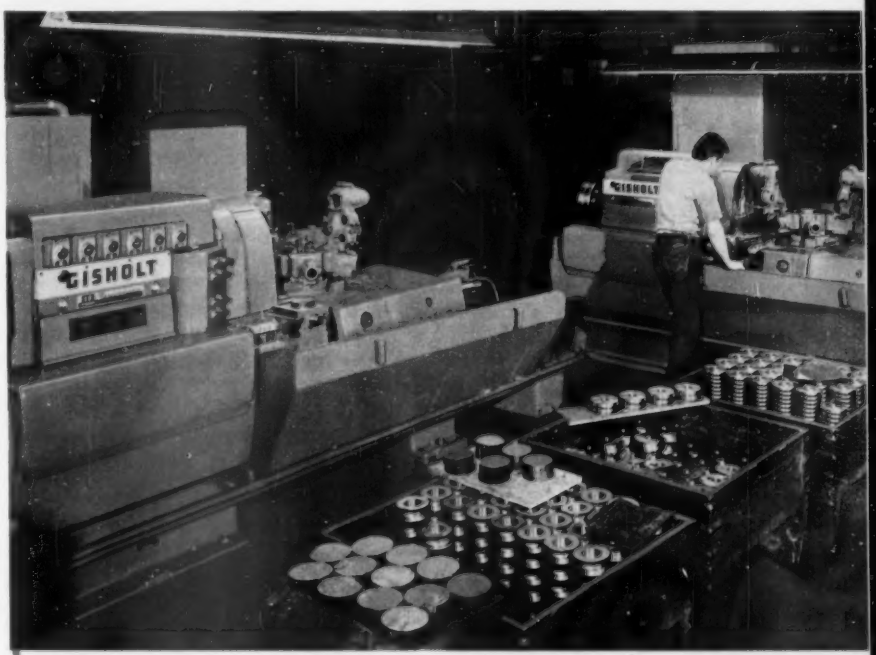
More cost-cutting IDEAS— to help you

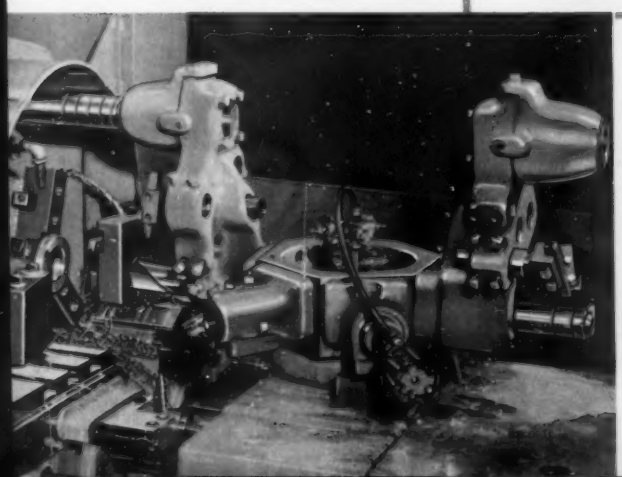
"PARTIALLY TOOLED" AUTOMATICS SHAVE 30 HOURS FROM 500-PIECE RUNS

Sheldon Machine Co. switches to Fastermatics for faster setup and automatic machining

Fastermatic® Automatic Chucking Turret Lathes can turn a neat profit even on jobs requiring only a fraction of their tooling capacity; for example, the two steel gear blank jobs shown here. Sheldon Machine Company, Inc., Chicago, builder of precision lathes, milling machines and shapers, formerly used hand-operated ram type turret lathes for this work. Now one operator using two "partially tooled" Fastermatics is saving 30 hours on one job and 32 hours on the other—every 500 pieces. In addition, the automatic cycle assures optimum tool life and repeat accuracy — .0002" to .0003" in bores.

Savings result from both faster setup and automatic cycle. One Fastermatic, a 1959 model, (shown at left), features the new Gisholt FeeDial® control. This permits the operator to preselect his feeds for any turret face in less than one minute — saving 5 minutes per station over earlier models. He can select his feeds, speeds and functions in less than 15 minutes simply by flicking switches and turning dials. Manual controls cut time normally required for preliminary tool setting, trial cuts and final adjustments.





One man operating two partially tooled Fastermatics saves a total of 62 hours on jobs A and B from time required on manually operated ram type turret lathes.

Job A: steel apron clutch gear before and after first operation. (Setup shown at left.) Thirty-two hours saved in two operations on 500-piece lots. Only three hex turret stations used to drill, turn portion of O.D., finish-bore and chamfer. Rear and front cross slides rough- and finish-face. Time, 4.8 min. f.t.f.

Job B: steel apron compensating gear before and after second operation. Thirty hours saved in two operations on 500-piece lots. Fastermatic at right above, set up to handle second operation. Only hex turret stations 1 and 4 used to finish-turn O.D., finish-bore and chamfer. Flange finish-faced from rear cross slide. Hub finish-faced and chamfered from front cross slide. Time, 2.7 min. f.t.f.

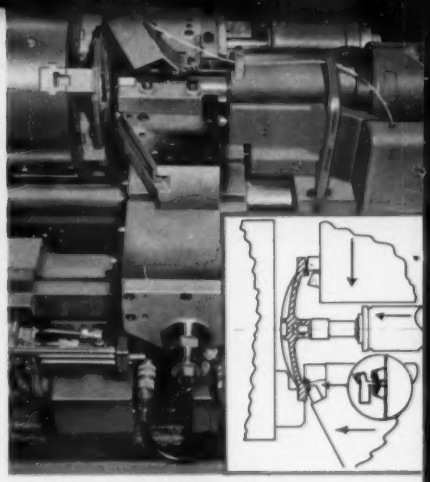
For information on the new Fastermatic with FeeDial control, circle or write in No. 729 on inquiry card.

COMBINED OPERATIONS CUT TIME 30% FOR ALMCO SUPERSHEEN

Motor-driven boring unit operates with standard tooling for extra efficiency

If you're machining parts similar to the cast iron stator and rotor cover plate shown, you might profit by studying this setup. Here a Gisholt MASTERLINE® No. 12 Automatic Chucking Lathe has a separate motor-driven boring unit operating with the standard tool slides. This permits completing two operations in one chucking. In use at Almco, Queen Products Division, King-Seeley Corporation, Albert Lea, Minnesota, this arrangement has improved accuracy, eliminated one operation and attendant work-handling, and achieved a 30% reduction in overall machining time.

Four different types of stator and rotor cover plates, in a wide range of sizes, are handled by one basic setup. Lots range from 1000 to 4000 pieces. The illustration and drawing show the setup for the most complex part. The cycle is as follows: Load work and chuck on O.D. at reduced pressure to eliminate possible work distortion; machine both faces from rear independent slide; front carriage tools bore at the base of the large O.D. face, size and undercut the pilot diameter and chamfer the edges. The boring unit operates with the front carriage. Carrying a multi-diameter cutter, it drills, co-bores, spot-faces and chamfers. F.t.f. time, only 1.5 min. F.t.f. times range from 1.3 to 1.5 min. on all parts handled, 30% less than before.



Note separate motor-driven boring unit actuated by front carriage, used to drill, co-bore, spot-face and chamfer. On forward movement of multi-diameter cutter and quill, wire automatically lifts guard, which drops back after operation is completed, protecting tool during loading and unloading. Layout at right shows how tools are located and the various surfaces they machine.

Throw-away tool tips and speeder boring unit permit proper surface speeds on all cuts — increase tool life 300%. Boring unit eliminates one operation.

For information on No. 12 Automatic Chucking Lathe, write in or circle No. 730 on inquiry card.

TRACING ON TURRET LATHES SPEEDS ROCKET ENGINE PRODUCTION

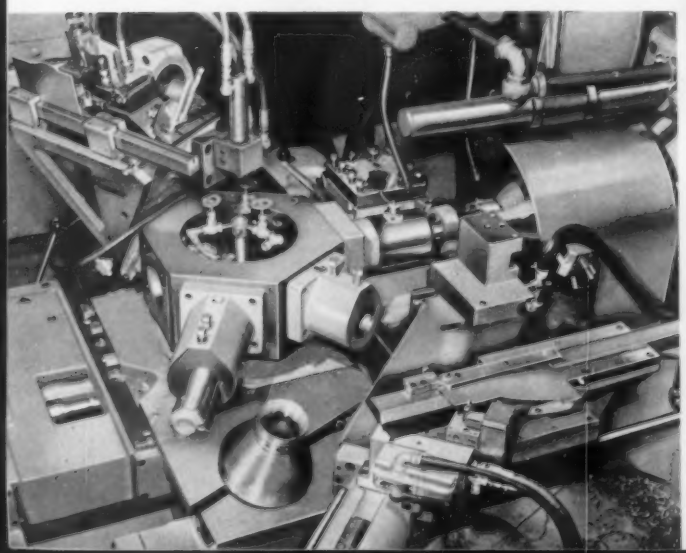
Battery of Gisholt Lathes averages 75% savings on wide range of complex parts

In equipping a new plant to produce prepackaged liquid propelled Guardian I and Guardian II rocket thrust units, Thiokol Chemical Corp.'s Reaction Motors Production Plant, Bristol, Pennsylvania, was faced with a number of tough problems. Work volume was low, but highly specialized; demand for low unit cost required minimum investment in equipment; maximum machine versatility was needed for quick change-over or retooling for design changes; a wide range of work required maximum machine capacity; close contract deadlines required quick machine delivery. Twelve standard Gisholt MASTERLINE® Ram and Saddle Type Turret Lathes were selected.

For contour turning, boring or facing, the lathes were equipped with JETracers to speed machining and eliminate chance of error. Included were JETracer® units for use on bridge-type cross slides, units to control a cross-feeding hex turret, turret-mounted slide tools and, in some cases, two different units on one machine. Because the work included such a wide variety of parts in an almost unlimited range of sizes, the Gisholt JETracers offered another important advantage: flat templates. These are quickly made, easily modified, and easily filed in minimum space for quick selection.

Here's maximum efficiency on short runs without high cost of special machines. JETracers and 12 Gisholt Turret Lathes average 75% savings.

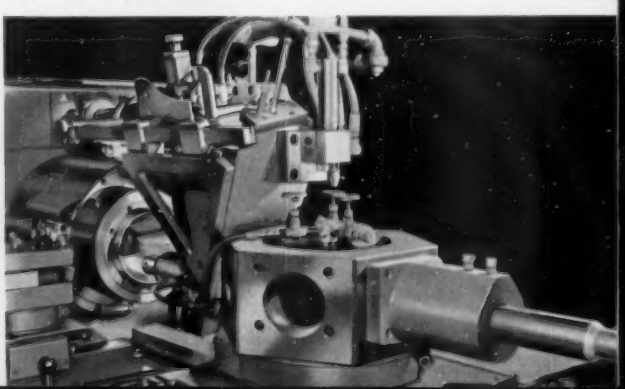
Gisholt MASTERLINE 3L with two JETracers for first operation on forged copper-alloy chamber nozzles. The end is faced from the front cross slide, then straight-bored from the turret. A turret mandrel supports the end during contour-turning by JETracer on rear of bridge-type cross slide, and grooving from front cross slide. Nozzle end is contour-bored by turret-mounted JETracer slide tool. F.t.f. time, 26.2 min.



For the complete story on this multiple-machine installation, write us for the magazine reprint "Turret Lathe Contouring of Rocket Engine Components."

Or write in or circle No. 731 on inquiry card.

Gisholt MASTERLINE 3L with turret-mounted JETracer slide tool, for second operation on chamber nozzles. Turret-mounted loader presses work into centralizing ring and holding fixture. Part is faced from front cross slide and the large I.D. is contour-bored with the JETracer. A 125 micro-inch R.M.S. finish is obtained, and tolerances of .002" are consistently held. F.t.f. time, 20.3 min.

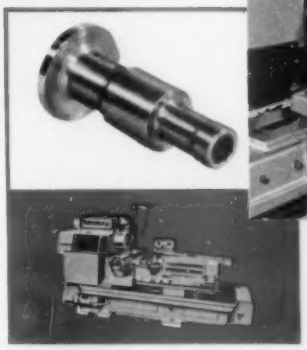


5 AR® SAVES 8 MINUTES PER PIECE FOR MURDOCK

JETracer on hex turret operates as part of automatic cycle

Doing small-run bar and chucking work on hand-operated machines or expensive single-purpose automatics? You'll be interested in the setup being used by Murdock Machine & Engineering Co., Inc., Wichita, Kansas.

Doing contract manufacturing, this firm specializes in milling and turning. In their own reasoning, a Gisholt AR (Automatic Ram Turret Lathe) was selected for its versatility in job shop operations requiring fast setup and standard tools . . . for its capacity to handle a wide range of both bar and chucking work . . . and for the economies offered by the automatic cycle. For an example of how the AR provides cost-cutting performance, read the caption at right.



AR Turret Lathe with JETracer saves 8 min. per piece. Savings average 50% on all jobs. Machine sets up as fast as a hand-operated turret lathe, changes from bar to chucking work in 30-40 min.

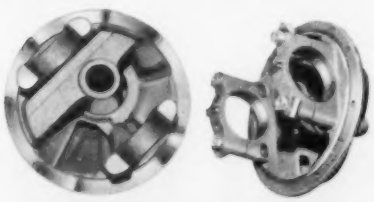
Murdock's No. 5 AR has an Air-draulic bar feed and a turret-mounted JETracer slide tool for contouring. Here's the cycle for a coupling shaft, shown, machined from 2"-diameter, hot rolled 4140 steel bar stock: stock feeds to length against turret stop; collet closes; hex turret boxturns two diameters; front cross slide rough forms two diameters and associated radii; turret-mounted JETracer automatically finishtraces from end face to O.D. of large flange end; hex turret drills, and rear cross slide cuts off. Then, cycle repeats. Time: 3 min., 15 sec. Previous methods, 12 min.

For information on No. 5 AR, circle or write in No. 732 on inquiry card.

SIMPLIMATIC® OFFERS "BUILDING-BLOCK" BENEFITS ON DIFFICULT PARTS

Independent slides positioned to suit the work for maximum efficiency

How would you machine the large O. D. face and the interrupted surfaces on these high-production parts? You could use a



specially designed machine — or a standard lathe requiring a sequence of cuts. Or you could use the Gisholt MASTERLINE Simplimatic Automatic Chucking Lathe which offers the best of both machines— at *standard* machine prices.

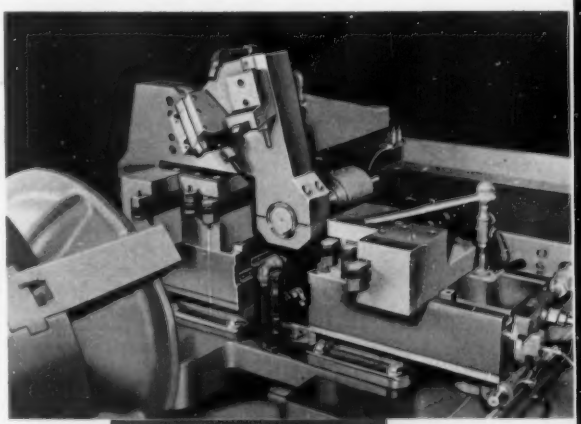
This versatile machine is the essence of the building-block principle: a standard headstock and bed casting; and a wide, flat platen table that permits the use of standard front, center, rear or auxiliary slides with tool blocks where they are *needed* for each job. Slides may feed at different rates, permitting an unlimited variety of cuts and tool approaches. The screw-fed table can advance rapidly to position the tools or can feed to plunge tools to depth, turn an O.D. or bore, before slide movements begin.

The captions tell how the two Simplimatic setups shown here are used by International Harvester Co., Inc.'s, Fort Wayne, Indiana, Motor Truck Plant, to handle the parts shown, above left.

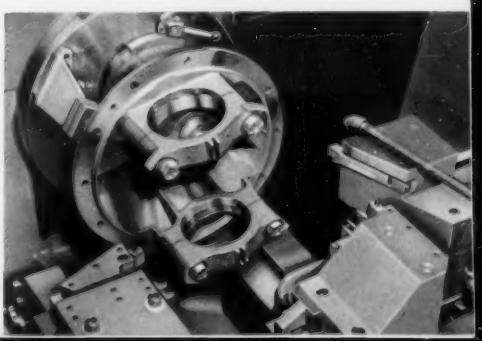
Over five sizes are handled with no additional tooling. Simplimatic offers maximum flexibility plus capacity . . . does the work of special machines at standard machine cost.

For information on Simplimatic Lathe, circle or write in No. 733 on inquiry card.

Setup for a cast iron, 20" O.D. differential carrier. The tools on front, rear, and pedestal-mounted center slides operate simultaneously. Flange is rough- and finish-faced; register diameter is turned and chamfered, and four half-bearing faces are machined. Time: 5 min. f.t.f. — compared to 9.68 min. by previous methods.



After a cap assembly is added, the work goes to a second Simplimatic. A spindle positioner speeds loading. Again, three standard slides are used — each positioned to suit the work. Register diameter is finished, and the four interrupted radii on the bearing cap ears are rough- and finish-turned and chamfered. Time: only 4.4 min. f.t.f. — compared to 7.59 by previous methods.



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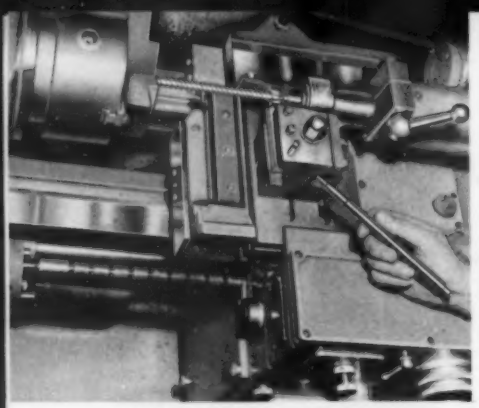
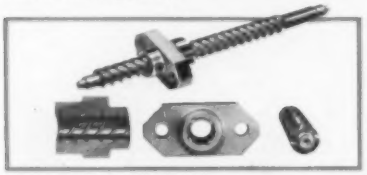


CRI-DAN "B" setup for 4-start adjusting screw, shown below. Note the stop roll at left of saddle. This permits cutting extra-length threads with no loss in accuracy.



Aircraft rudder pedal adjusting screw and nut assembly (for Lockheed Model C-130 airplane) shown at top. Bottom (left to right): adjusting nut, sectioned and end view to show internal 4-start thread; adjusting-screw end view to show 4-start thread.

CRI-DAN SAVES 65 MINUTES ON 4-START THREADING JOB

Single-point threading tools eliminate thread milling and expensive taps

Interested in cutting threading costs? Then you'll want to study this Gisholt CRI-DAN "B" Threading Lathe setup used by Orlando Machine Tool Co., New Smyrna Beach, Florida.

Two parts are involved: a long aircraft rudder pedal adjuster screw made of SAE 4130, heat-treated to 25-30 Rc, and a mating nut, made of aluminum bronze. Parts are used on the Lockheed Model C-130 airplane.

The screw requires a ½"-10 4-start Acme thread, with 1" lead, 5¾" long, .060" deep. Previously, this thread was milled in 1½ hours. Now a CRI-DAN "B" completes the part in only 25 min. f.t.f. The CRI-DAN is equipped with a 64-pass mechanism and a special stop roll that permits completing the 5¾"-long thread even though standard machine capacity is 3¼". After cutting part of the thread the saddle is re-located, using the stop roll. Accurate lead pickup is assured with no loss in accuracy, even on this tough, 4-start threading job. The single-point tool makes 60 automatic passes with .001" tool in-feed per pass, producing a 65 micro-inch R.M.S. finish.

The nut requires 32 passes, with .002" in-feed per pass. F.t.f. time, 15 min. Tap costs alone would have been $490. Compare this to the cost of single-point tools used by the CRI-DAN.

CRI-DAN "B" saves 65 min. per adjusting screw . . . uses cost-cutting, single-point tools in place of milling cutters or taps. Stop-roll feature stretches threading capacity with no loss in accuracy.

For complete information on CRI-DAN Threading Lathe, write in or circle No. 734 on inquiry card.

MISSILE GYROS BALANCED FASTER, MORE ACCURATELY ON GISHOLT HS

Air drive and special fixture simplify balancing of unusual part

If your work includes miniature high-speed parts or assemblies, you'll find Gisholt HS Balancers of interest. These machines handle armatures, aircraft and missile gyros, small spindles, turbines, etc. They accurately measure and locate unbalance causing movements as small as .000002".

An example is the piece shown here — a Rolleron Gyro manufactured by R. C. Allen Business Machines, Inc., Grand Rapids, Michigan. This unit is used to stabilize the Sidewinder aircraft-fired missile. Powered by air streaming past the stabilizing fins on the missile, the toothed wheel attains very high rotational speeds. Extremely close tolerances must be held to assure proper functioning.

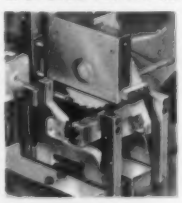
Shown on a Gisholt HS-2 Balancer, air drive accelerates the assembly to 8000 r.p.m. in just 5-8 seconds. Readings are taken in two correction planes. A light-dark finish variation on the toothed wheel triggers a photo tube pickup. This provides angle reference and indicates speed through a tachometer. Amount, in terms of drill depth and angle of unbalance is shown on separate direct-reading meters.

To maintain tolerances of less than 100 micro-ounce inches in each plane, the assembly passes through the balancer three times for a rough correction, final tolerance correction and inspection. Production —40 to 50 assemblies per 8-hour shift.

Gisholt HS-2 Balancer provides more accurate plane separation, angle indications and amount measurements, eliminating excessive correction cycles. Balancer is easily changed over to belt drive for other gyro parts.

For complete information on HS Balancers, write in or circle No. 735 on inquiry card.

Gisholt HS-2 Balancer with fixture supporting Rolleron Gyro assembly. Note direct-reading amount and angle-of-unbalance meters at top right, and expanded scale tachometer below. Inset: Rolleron Gyro, with paper clip for size comparison.



Close-up of part in fixture. Note air-drive orifice at base of toothed wheel that accelerates the wheel to 8000 r.p.m. in 5-8 seconds, and maintains speed during location and measurement of unbalance.

Correction drill press has micrometer depth adjustment. Placed in a fixture, work is corrected in one plane, then turned and located at other end of fixture and swung under drill for second plane correction.

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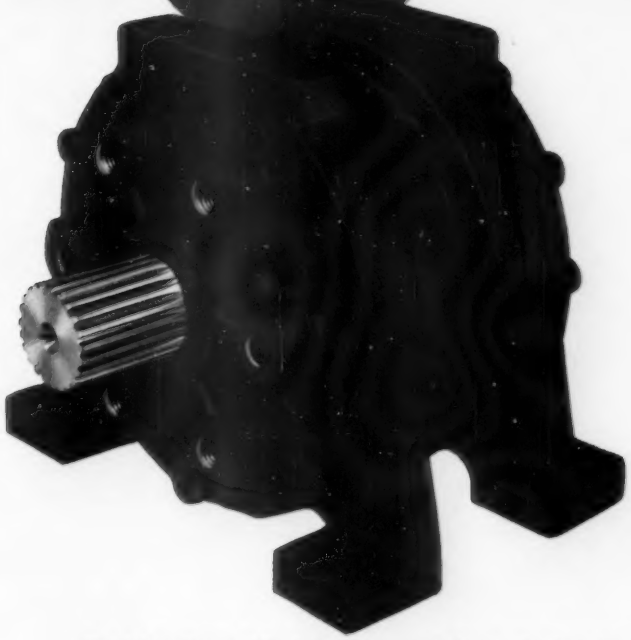

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Houdaille, the world's foremost manufacturer of rotary type hydraulic equipment, now introduces a compact and powerful hydraulic rotary actuator for industrial use. Called HydRoAc, the Houdaille unit is designed to be used in a tremendous variety of applications ranging from turret lathes to farm machinery—from dump trucks to printing presses.

The superiority of Houdaille HydRoAc units is indicated by these specifications for standard units now available.

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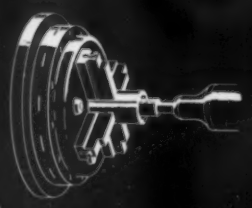

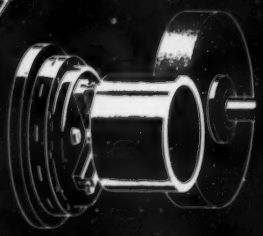

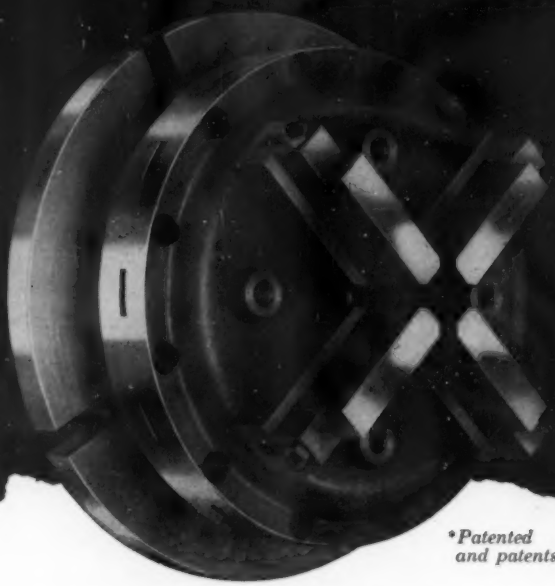

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- √ *eliminates air leakage*

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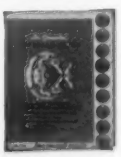

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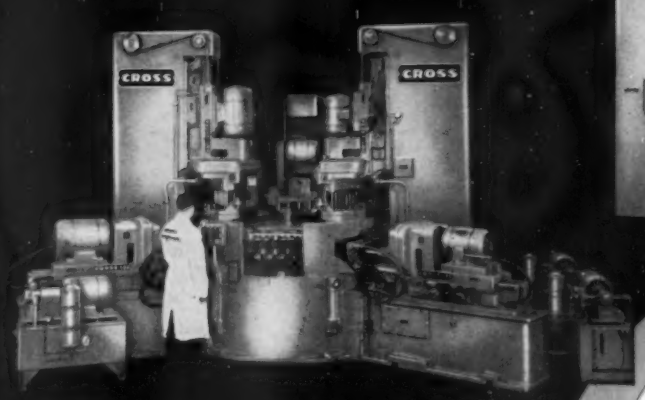
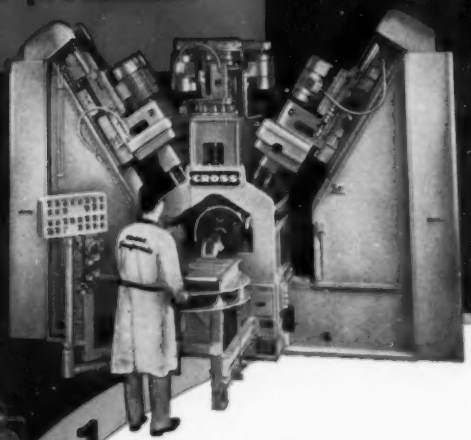
6 ways to automate

Cross automation takes many forms . . . from the simplest low production machines to complex equipment for mass production.



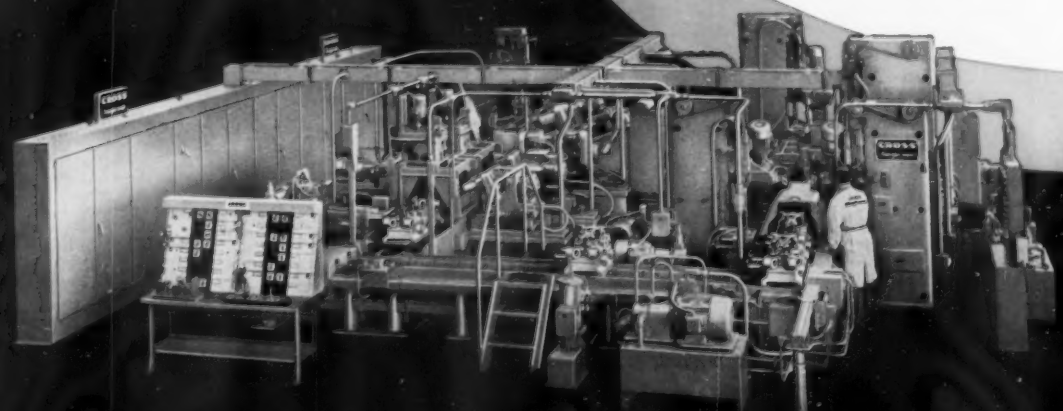


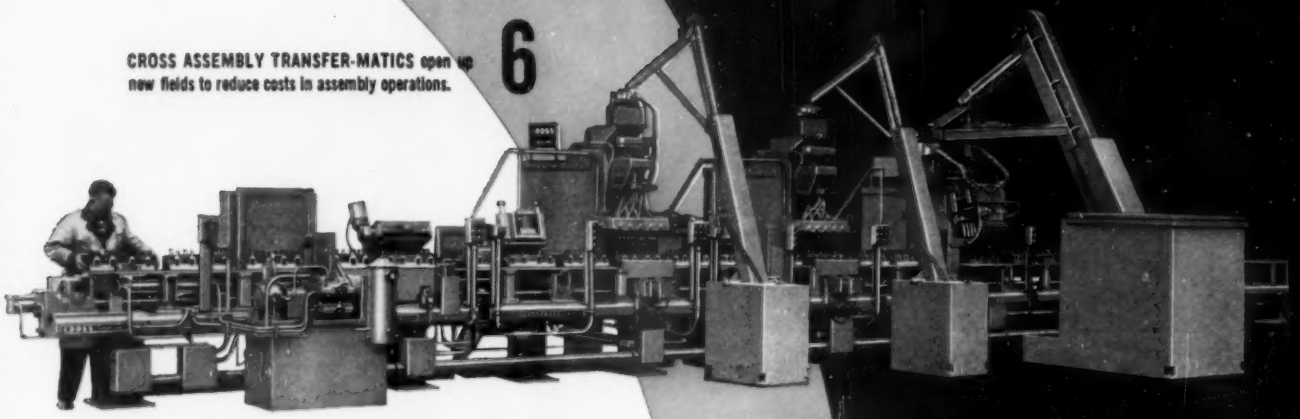
1 **CROSS SINGLE STATION MACHINES** exist in many configurations to combine operations.

2 **CROSS DIAL TYPE MACHINES** provide multiple station performance with minimum floor space.

3 **CROSS TRUNNION TYPE MACHINES** are compact multiple station units that permit operations on opposite sides of the part.

4 **CROSS PALLET TYPE TRANSFER-MATICS** provide capacity for combining a large number of operations. Standard pallet fixtures handle irregularly shaped parts with maximum flexibility.





CROSS ASSEMBLY TRANSFER-MATICS open up new fields to reduce costs in assembly operations. **6**

The six machine types illustrated here were created by Cross to apply the principles of automation to a wide variety of metalworking operations. Thus, Cross makes available the benefits of automation to small or large manufacturers, regardless of required production volume.

Cross sales engineers are available to discuss your automation problems with you. They will also be glad to discuss the new Cross Process Development Service created to solve *unusual* automation problems—in or out of the metalworking field.

CROSS SECTIONIZED TRANSFER-MATICS provide a means of combining unlimited numbers of operations. Automatic in-process work storage minimizes downtime and increases operating efficiency. **5**

Established 1898

THE **CROSS** CO.

First in Automation

PARK GROVE STATION • DETROIT 5, MICHIGAN

NEW TOOL STEEL SERVICE

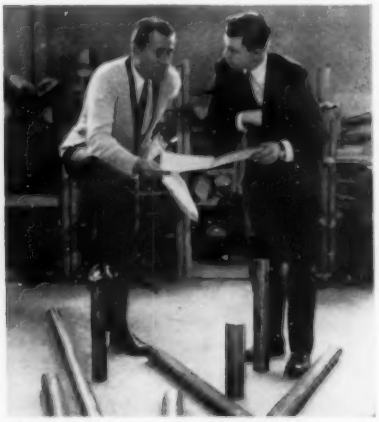
cuts
inventory
costs

Using too many grades of tool steel can lead to over-stocking —

that's when you need the benefits of Crucible's new Tool Steel Service!

A Crucible Service Engineer can prove that buying a few basic grades —

in quantity — enables you to carry fewer pounds in stock . . .



gives you a lower price per pound (you eliminate small quantity "extras").

and with fewer grades to identify, you reduce the possibility of "mixed" steel.

All through standardizing on a few basic steels!

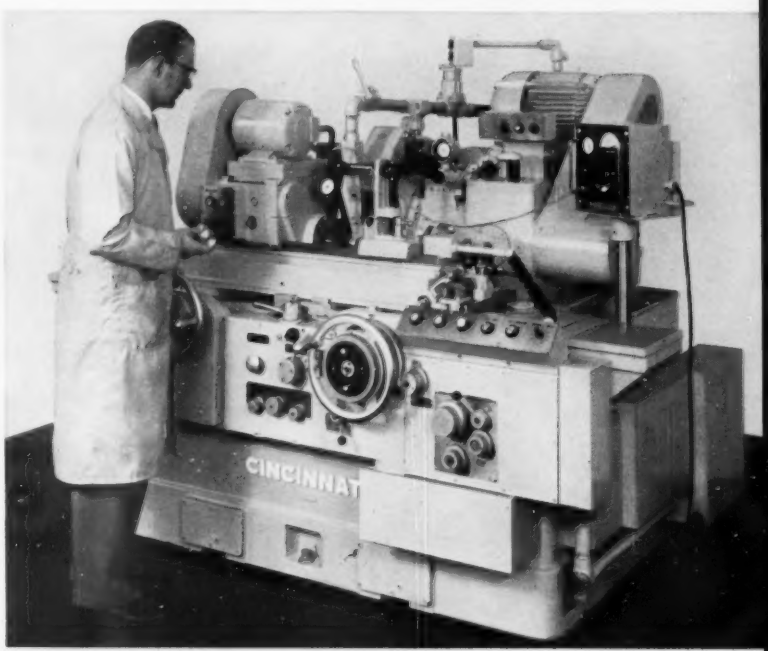
For the full story on this cost-reducing service, call in a Crucible Service Engineer

CRUCIBLE STEEL COMPANY OF AMERICA

Branch Offices and Warehouses: Atlanta • Baltimore • Boston • Buffalo • Caldwell, N. J. • Charlotte • Chicago • Cincinnati • Cleveland • Columbus • Dallas • Dayton Denver • Detroit • Erie, Pa. • Grand Rapids • Houston • Indianapolis • Los Angeles • Miami • Milwaukee • Minneapolis • New Haven • New York • Philadelphia Pittsburgh • Portland, Ore. • Providence • Rockford • Salt Lake City • San Francisco • Seattle • Springfield, Mass. • St. Louis • E. Syracuse • Tampa • Toledo • Tulsa
CRUCIBLE STEEL OF CANADA, LTD., SOREL, QUEBEC, CANADA

Compare automatic infeed systems...see why

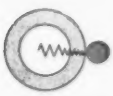
ACRASIZE CONTROL is the best



CINCINNATI FILMATIC 10"R x 18" Plain Grinding Machine equipped with the timesaving feature-advantages diagramed in the chart below. Catalogs G-688 and G-661-2.

CINCINNATI ACRASIZE is the exclusive gage control system which calls the signals for the entire automatic infeed grinding cycle. Maximum timesaving and extra high quality are attained by combining:

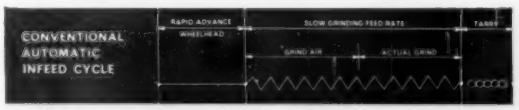
Automatic Dual Rate Infeed (lever or push-button operated) provides fast, accurate grinding cycles with dual feed rates . . . coarse feed for rapid stock removal, and a smooth, continuous fine feed to exact size. No gage required.

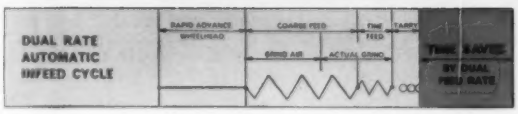


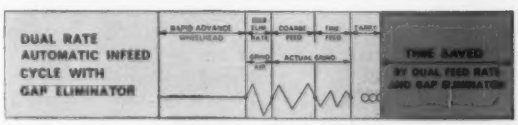
Automatic Gap Eliminator reduces infeed cycle time. This Cincinnati development saves up to 75% of the time normally wasted in grinding air.

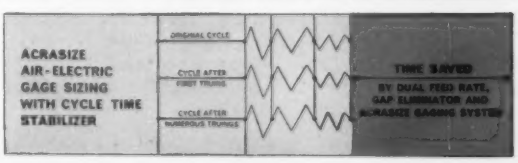
ACRASIZE *Gaging with Cycle Time Stabilizer* completely controls the grinding cycle. Effects of machine thermal changes, wheel wear and work variations are eliminated. Cycle time always remains constant.

These three Cincinnati feature-advantages give you a basis for comparison of automatic infeed systems. Check them all and you'll see why Cincinnati produces the highest quality work at rock-bottom cost. **Grinding Machine Division, The Cincinnati Milling Machine Co., Cincinnati 9, Ohio.**








ACRASIZE AIR-ELECTRIC GAGE SIZING WITH CYCLE TIME STABILIZER
ORIGINAL CYCLE
CYCLE AFTER FIRST TRUING
CYCLE AFTER NUMEROUS TRUINGS
TIME SAVED BY DUAL FEED RATE, GAP ELIMINATOR AND ACRASIZE GAGING SYSTEM

CINCINNATI®
GRINDING MACHINE DIVISION

PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • MICRO-CENTRIC • ROLL • CHUCKING • CENTERLESS LAPPING

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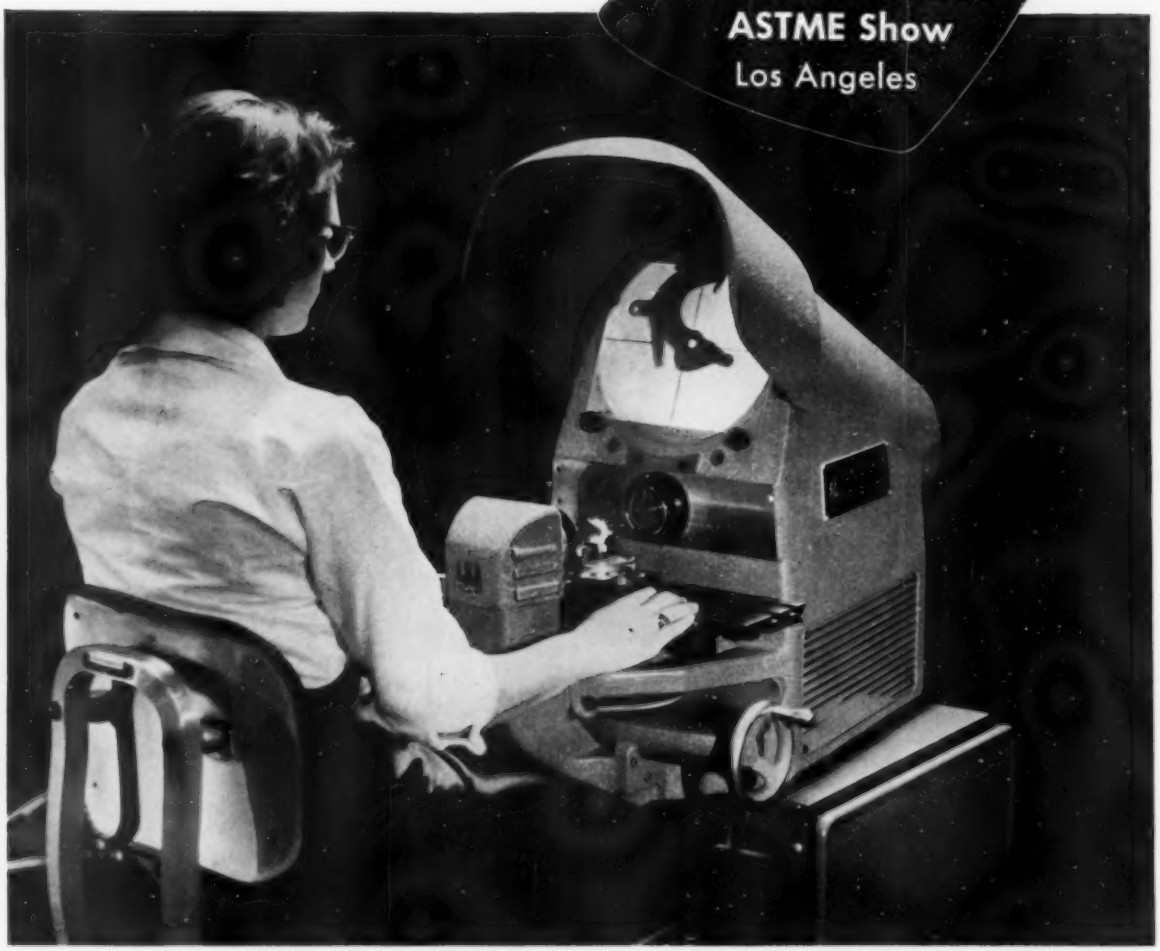
JONES & LAMSON
OPTICAL COMPARATORS

See them at
Booth No. 308
ASTME Show
Los Angeles



Now . . . an Economy-size Optical Comparator with "Big Machine" Features

Here is a fine optical inspection and measuring instrument of brand-new design. It is the first small-screen comparator to offer such BIG performance. It is equally suitable for production-line operation or job-shop work, and is extremely flexible in application.

The J & L TC-10 is of precision machine tool construction. This provides a solid base for precise inspection and measurement.

Three different table styles are available, including a fixed table for straight comparison work, a plain table, and a measuring table which gives you 6 square inches of measuring area. All measurements are read directly to .0001", without computation.

Among other things, the TC-10 is adaptable for *reflection inspection*. Reflected images are extremely sharp—even at high magnifications.

Other "big machine" features include Angle Measuring; Quick-Change Lens Mount; Vertical Staging; Tracing Inspection. And there's a big bonus in the 5X, 2" aperture lens, which gives inspection capacity and accuracy hitherto unattainable on a machine of this size. Write for folder. Jones & Lamson Machine Company, 25 Clinton St., Springfield, Vt.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

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Use Reader Service Card, CIRCLE 26

LINDE COMPANY

UNION CARBIDE

SIGMATIC

NEW ALL-IN-ONE "MIG" WELDING EQUIPMENT

Welding equipment is designed, developed and refined, but eventually it must be redesigned. LINDE'S new SIGMATIC line of "Mig" welding equipment is a product of this evolution . . . plus LINDE'S vast experience with more inert-gas and consumable-electrode processes than any other company in the world. The SIGMATIC line is the most-versatile semi-automatic equipment available anywhere—one machine for:

- **. . . all types of "Mig" welding—spray arc, short arc and spot welding**
- **. . . in all welding positions—vertical, overhead or downhand**
- **. . . with all shielding gases—argon, helium, CO_2, or their mixtures**
- **. . . and all wires—hard or soft, solid or tube**
- **. . . on all weldable metals—carbon steel, stainless, aluminum, magnesium, titanium**
- **. . . on all thicknesses—sheet metal and up**

See next page for details.

SIGMATIC

One SIGMATIC machine for... spray arc... short arc... spot welding

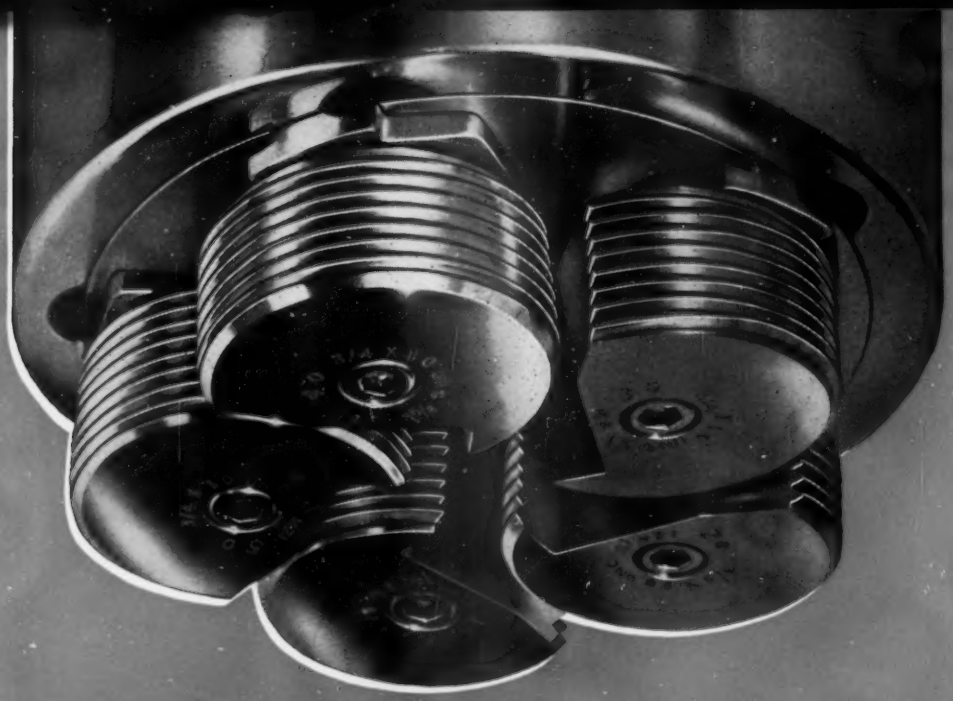
Spray arc, short arc, spot welding...never before combined in a single piece of equipment. SCC-8 control incorporates special spot-welding circuitry, featuring a directly-calibrated, precision weld timer and an independently-adjustable, "non-stick" timer. Converts from spot to continuous fusion welding at the flick of a switch. SEH-2 heavy-duty wire-feed unit--largest, most-rugged unit available today—permits positive feed of all "Mig" wire types, metals and diameters. The SIGMATIC line contains five basic units, designed with interchangeable parts permitting more than 50 combinations tailor-made to individual specifications. Available in cart-, sled- or bench-type units.

Unique controls are vastly simplified. All components are visible and accessible. Adjustments can be made with a screw driver. Only heavy-duty industrial-type parts are used throughout each unit to insure dependable, long-life performance with minimum maintenance. Top-quality parts—"Square D" pneumatic timers, Mallory electrolytic condensers, Cutler-Hammer switches, Potter & Brumfield relays, Electrons, Inc. thyratron tubes. The SIGMATIC line is unquestionably a major welding advance—with one rugged, durable machine, you can do any type of "Mig" welding in any position on any thickness of any metal. For more information or a live demonstration, call your nearest Linde office.

"Linde," "Sigmatic" and "Union Carbide" are registered trade marks of Union Carbide Corporation

LINDE COMPANY UNION CARBIDE

Division of Union Carbide Corporation
270 Park Avenue, New York 17, N.Y.



RIDGID® reports on the 5-Chaser Vers-O-Tool

Ups pieces-per-grind from 200 to 3000!

Here's more startling evidence of how NAMCO 5-Chaser Vers-O-Tools pay off in increased threading efficiency. States Horace Ives, Automatic Machine Foreman at Ridge Tool Company, manufacturer of famous RIDGID pipe tools, Elyria, Ohio: "Since switching to a NAMCO 5-Chaser Vers-O-Tool for threading our Nipple Chuck adaptor, we get consistently accurate threads at lower cost. Pieces-per-grind have increased from 200 to 3000; set-up and change-over time is hours less. And, because we get our required Class 2 thread *every time*, scrappage is practically non-existent." These are common comments from users of NAMCO 5-Chaser Vers-O-Tools. In your shop, too, they'll give threading efficiency you never believed possible. Call, write or wire for complete information.

National Acme

THE NATIONAL ACME COMPANY
193 E. 131st STREET
CLEVELAND 8, OHIO

Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.

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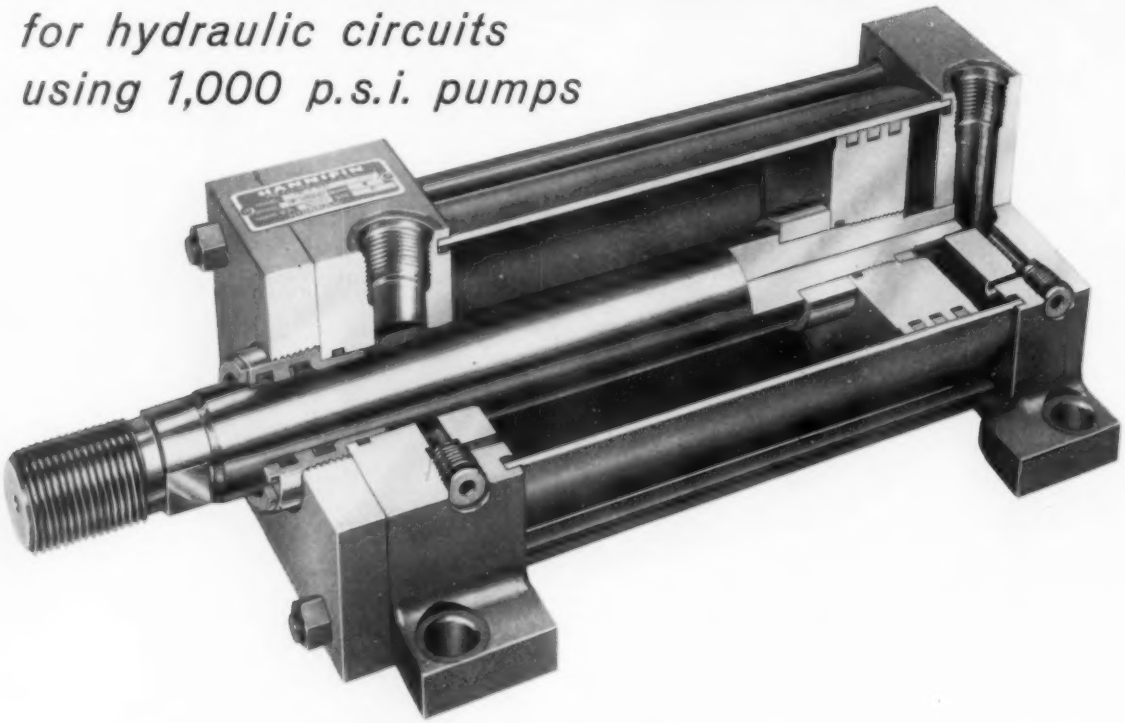
NEW FROM HANNIFIN
THE THOUSAND POUND LINE!

for hydraulic circuits
using 1,000 p.s.i. pumps



- *A true hydraulic cylinder – not a modified air cylinder*
- *Offered in nine bore sizes – 1" through 8"*
- *Every model withstands at least 1,000 p.s.i. in every bore size*
- *Built to save you money – yet not "built to a price"*

Now, for the first time in hydraulic cylinder manufacture, Hannifin offers a top quality cylinder tailored to the medium-high-pressure hydraulic circuits you operate off 1,000 p.s.i. pumps.

Series "L," the "Thousand Pound Line," is NOT a modified heavy duty air cylinder. It is built for the job . . . with steel heads and steel barrel for full compliance with J.I.C. hydraulic recommendations. Other extra-quality features include an induction hardened and hard chrome plated rod, nodular iron piston with cast-iron piston rings — leakproof "Lipseals®," optional — longer cushions on cushioned models, and the Hannifin-developed bronze cartridge gland with both "Lipseal®" and "Wiperseal" to keep the rod drip-free. S.A.E. straight thread "O" ring ports as recommended by J.I.C. are optional at no extra cost just as they are in the Hannifin heavy duty Series "H" hydraulic cylinder.

Parker-Hannifin field engineering service can help you meet your needs precisely, help you select the proper Hannifin cylinder for any service, air or hydraulic. Call your nearest Parker-Hannifin sales office or write direct for our new bulletin giving all dimensions of Hannifin Series "L" cylinders.

PARKER HANNIFIN CORPORATION

HANNIFIN COMPANY
A DIVISION
519 South Wolf Road • Des Plaines, Illinois
PNEUMATIC AND HYDRAULIC SYSTEM COMPONENTS

3077-PM

NEW

CAPEWELL

COILGUARD

band saw dispenser

EASIER TO STOCK, IDENTIFY AND USE

★ Coilguard is designed and engineered to guarantee smooth easy dispensing and recoiling. Cut end does not protrude.

★ Coilguard's high impact plastic protects band saws in transit and in the warehouse. Two-way labeling permits identification when stacked vertically or flat.

★ Special nesting pins allow "shoulder to shoulder" stocking. Hex shape prevents rolling.

★ Through center hole facilitates handling, is ideal for mounting on pegs or pipes for dispensing.

Only Capewell Distributors carry bandsaws in the convenient Coilguard package. One more reason why your Capewell Distributor should be your source for all the saws you need—hand hack saws, power hack saws, band saws and hole saws.

INDUSTRIAL DISTRIBUTORS — SERVING INDUSTRY ECONOMICALLY — THE RIGHT HAND OF PRODUCTION

CAPEWELL 1881

THE CAPEWELL MFG. CO., HARTFORD 2, CONN.

CALCULATED TO CUT COSTS

Every CARD tap is an exact geometric duplicate of every other CARD tap of the same size and type. This precise repetition keeps your production consistently high . . . and costs low. Your CARD Distributor can make fast deliveries of the exact types of tap, die, gage, or screw plate you need. Your CARD technical man has complete details on their use. S. W. CARD DIVISION, Mansfield, Mass. Card Warehouses: Atlanta, Chicago, Detroit, Fort Worth, Los Angeles, New York and San Francisco.

CARD

DIVISION OF UNION TWIST DRILL COMPANY

Serving you through the best distributors from coast to coast

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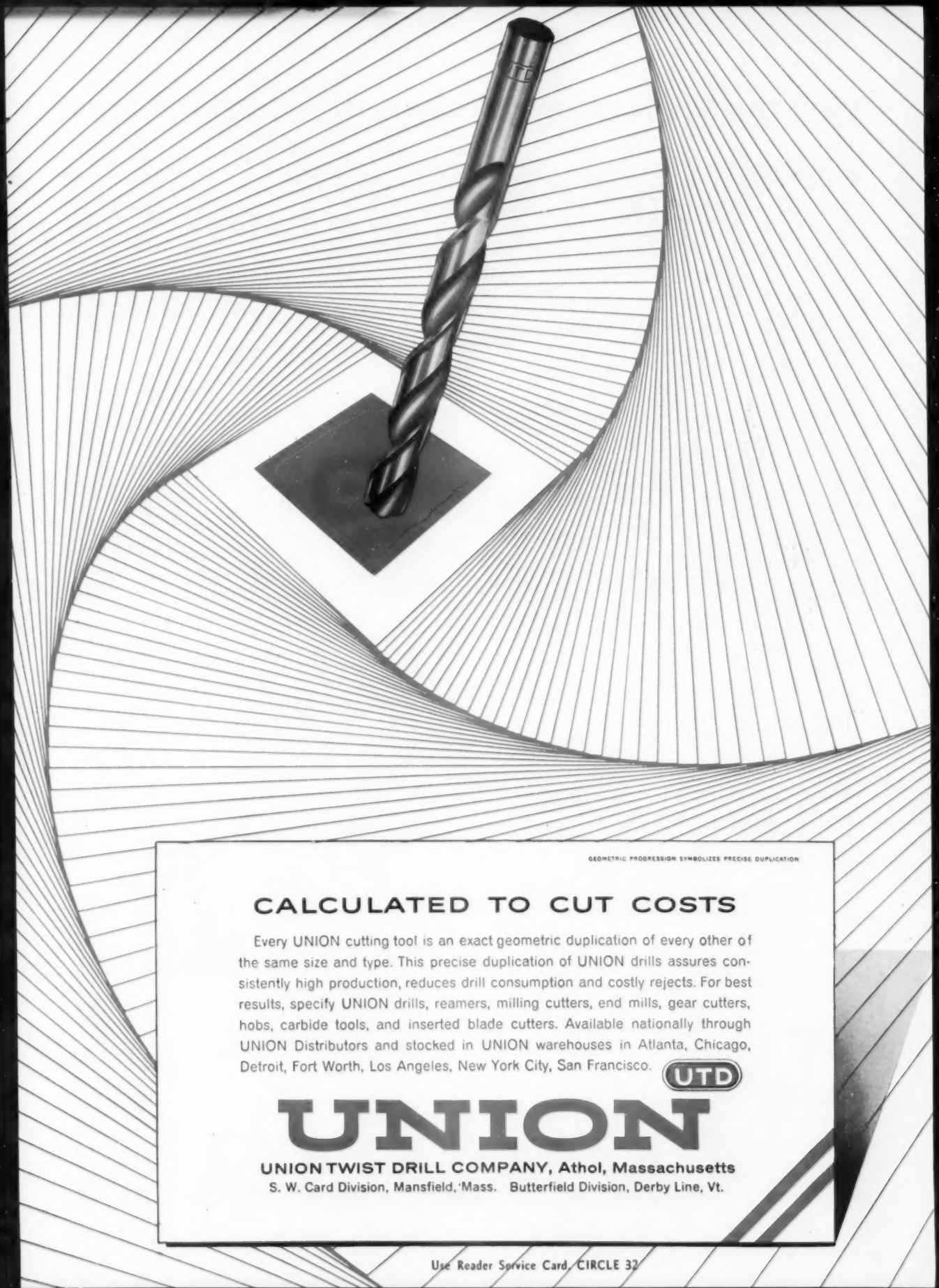

GEOMETRIC PROGRESSION SYMBOLIZES PRECISE DUPLICATION

CALCULATED TO CUT COSTS

Every UNION cutting tool is an exact geometric duplication of every other of the same size and type. This precise duplication of UNION drills assures consistently high production, reduces drill consumption and costly rejects. For best results, specify UNION drills, reamers, milling cutters, end mills, gear cutters, hobs, carbide tools, and inserted blade cutters. Available nationally through UNION Distributors and stocked in UNION warehouses in Atlanta, Chicago, Detroit, Fort Worth, Los Angeles, New York City, San Francisco.

UTD

UNION

UNION TWIST DRILL COMPANY, Athol, Massachusetts

S. W. Card Division, Mansfield, Mass. Butterfield Division, Derby Line, Vt.

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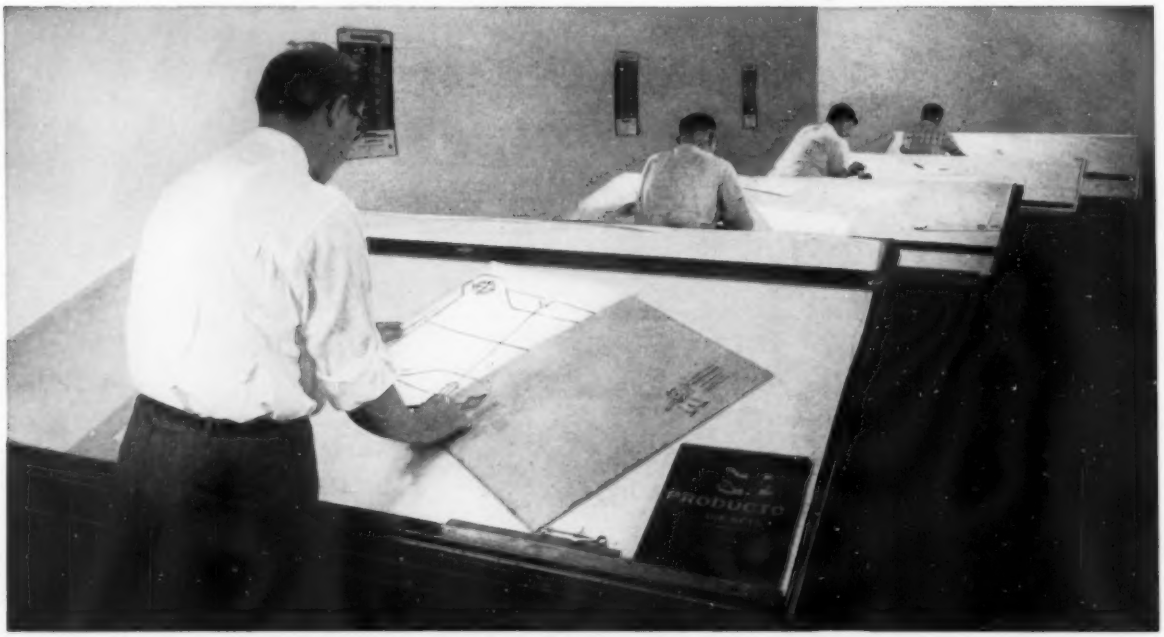
Why the Die Designer Prefers PRODUCTO Die Sets



He can specify Producto with complete confidence

The die designer likes to specify Producto die sets on his blueprints because they are a nationally-accepted "brand." They're easy to get anywhere... and delivery is prompt.

He favors Producto because he knows he never has to compromise his die design. Even if the die layout is a little unusual, he will be able to select a die set to accommodate it from Producto's wide range of thicknesses and styles.

He also knows Producto has the equipment that can cut his tooling costs by letting him adapt his sets to a more economical *basic* design. Only Producto offers him complete foundry, pattern-making, welding and machining services for his special requirements.

The die designer recognizes Producto's Qwik-Fit Guide Pins as an important new feature that die makers want. He specifies them because they save up to 75% of the time normally required for die set assembly and disassembly.

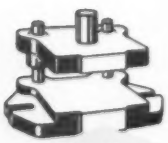
The die designer likes to use Producto's new catalog, the industry's most practical tool. His die layout is simplified when he uses Producto die set templates. And Producto provides him with cost-saving ideas in the DIE SET DIGEST.

Most important, he can depend on *consistent* Producto die set accuracy to transfer from the drawing board to the press the precision and ingenuity of his die design.

Yes, the designer has found that Producto die sets justify his confidence in specifying Producto. You will, too.

TWO FREE AIDS to more economical, efficient use of die sets are available from Producto. All-new CATALOG NO. 11 makes ordering and selection job easy. DIE SET DIGEST gives valuable tips for designers, builders and users of dies. Write for them today.

THE PRODUCTO MACHINE COMPANY
925 Housatonic Ave., Bridgeport 1, Connecticut



Wherever die sets are used

PRODUCTO

PRODUCE MORE WITH PRODUCTO PRECISION DIE SETS

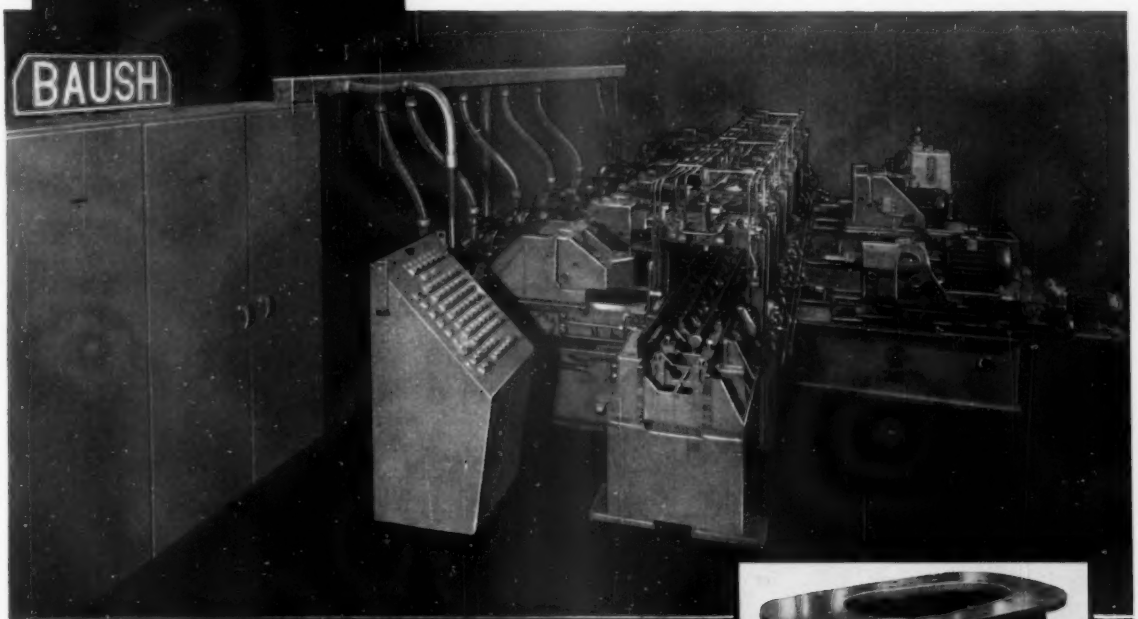
FOR USE IN GREAT BRITAIN

A 10 Station Baush Horizontal Automatic Transfer Line built for a leading British automobile manufacturer to perform operations on top and bottom of transmission case.

This 10-station horizontal transfer consists of —

- 1 Loading Station
- 7 Working Stations
- 1 Blow-off Station
- 1 Unloading Station

The transfer line is made up of 4 Horizontal Hydraulic Slide Units and 5 Horizontal Mechanical Leadscrew Units having 9 Fixed Center Heads equipped with a total of 32 spindles.



Operations performed are: Mill, Drill, Ream, Countersink, Chamfer and Tap. Individual leadscrew spindles are used for tapping and lubrication is by air-oil mist.

Production is 62 Transmission Cases per hour, or 1984 operations, working at 100% efficiency.

If it is rugged reliability, accuracy and economy of operation you are looking for in single purpose multi-spindle machine tools, then you want BAUSH MACHINE TOOLS.

BAUSH
MACHINE TOOL CO.
SPRINGFIELD 7, MASSACHUSETTS

We know Baush can help — why not call us!

IF YOU MAKE RING-SHAPED TOOL PARTS

...This hole is money in your pocket

You cut the cost of making ring-shaped tool steel parts when you make them from Graph-Mo Hollow Bar®. You can start with finish boring because the hole's already there. You eliminate one big machining operation.

And you keep right on saving. You'll machine Graph-Mo easier because the free graphite in its structure makes it machine 30% faster than ordinary tool steels.

Your Graph-Mo parts will last longer too. Diamond-hard carbides in its structure make it outlast ordinary tool steels three to one, according to actual user reports.

You can't beat Graph-Mo for stability, either. A master plug gage made of Graph-Mo showed less than ten millionths of an inch dimensional change after twelve years of use.

There is only one Graph-Mo and the Timken Company makes it. Buy it in the hollow bar form for your ring-shaped tool steel parts and save. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO." Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.

TIMKEN®
Fine Alloy **STEEL**

TIMKEN GRAPHITIC STEELS ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 40 CITIES IN THE UNITED STATES AND CANADA

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"...and safe at 150% of specified maximum speed..."

Every Peninsular wheel must pass this test—must prove before delivery to you that it can safely take half again as high a speed as the maximum safe speed recommended.

It is one of a series of grueling tests developed by Peninsular to make sure that its wheels—vitrified or resinoid—are the safest and highest performance wheels you can find anywhere.

Our 1960-1961 catalog is now off the press. Ask for your copy today.

PENINSULAR

GRINDING PENINSULAR SINCE 1900 **WHEELS**

District Representatives and Distributors in All Principal Cities

PENINSULAR GRINDING WHEEL COMPANY • 729 MELDRUM AVENUE • DETROIT 7, MICHIGAN

Thor

Everything you want in Torque Control···

and more!

Thor Uni-Tork screwdrivers and nut setters make torque control of threaded fasteners as simple as turning on a light. Operator judgment and guesswork is gone. Uni-Tork snaps out of engagement when desired torque is reached, snaps in again when applied to the work. Thor Uni-Tork air tools have external torque adjustments from 10 to 100 inch-pounds. Available on all Thor air screwdrivers and nut setters and on Thor electric tools. Your Thor factory representative or distributor will show you the tools that think for themselves. Thor Power Tool Company, Aurora, Illinois. Branches in all principal cities.

ASSEMBLE ACCURACY

into your special machines

EXTREME ACCURACY AND RIGIDITY . . . because rugged, unit-cast body assures precise alignment. Heat treated wear parts and precision ball and roller bearings used throughout.

FAST CYCLING . . . with multiple disc clutch and brake to engage and disengage feed train from spindle drive.

VERSATILE . . . because readily available commercial quick-change pick-off gears are used in feed train. Three drive arrangements are available.

POSITIVE ACTION . . . and dependable performance through countless cycles. Closed cam design insures fast, positive quill return without use of springs.

DATA . . . 3½" stroke; 6000 rpm maximum spindle speed; 1000 pounds maximum thrust; 3 horsepower motor maximum.

FOR COMPLETE INFORMATION . . . write for Catalog No. 508.

At the same time, ask for information on Hartford Special's lines of Air Hydraulic Drill Units, including the all-new Model 17-400.

HARTFORD Special

THE HARTFORD SPECIAL MACHINERY CO.

3800 College Highway, Simsbury, Connecticut

Heavy Equipment Manufacturer

doubles production — cuts tool inventory 75%

with ADAMAS Carbide Products!

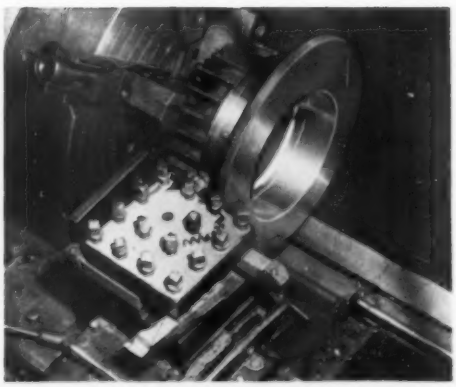
GET CONSISTENTLY HIGHER PERFORMANCES LIKE ESSICK

Two years ago Essick Mfg. Co., Los Angeles, was concerned with production lags, and excessive carbide tool costs and inventories. Essick tried various sources for inserts and holders but the tips would either pull out or fail to control the chip.

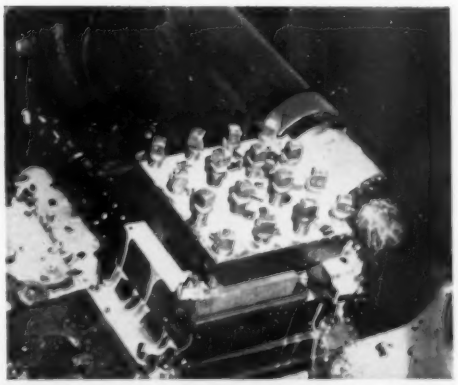
An Adamas advertisement influenced Essick's M. L. Taylor, Gen. Supt., and R. E. Drake, Div. Supt., to investigate Adamas carbide inserts and Dex-A-Tools. The adjustable chipbreaker control principle designed into the tool indicated a possible solution to Essick's problems.

Adamas Dex-A-Tools with Grades 434 and 548 inserts now handle practically all Essick applications with heavier feeds and higher speeds, and closer tolerances than those obtained with competing tools and inserts. Essick has reduced downtime . . . substantially increased output . . . lowered inventory of carbide and tools by 75%.

Roy Houck, District Manager — Adamas' Los Angeles office, furnished tool engineering assistance in the development of these applications.

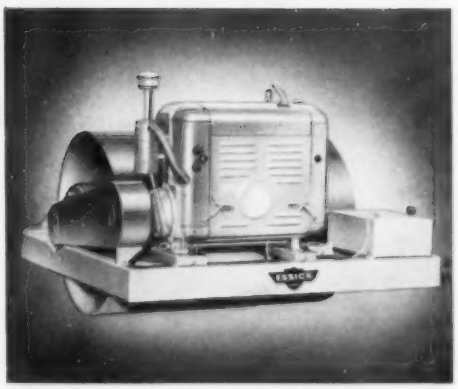


ADAMAS Dex-A-Tool and Grade 548 triangular insert turning bearing housing 11.00" diam. This operation now takes 20 minutes . . . previous performance with competitive tools took 30 minutes. Time saved 33⅓%.



ADAMAS Dex-A-Tool and Grade 434 triangular insert turning vibrator shaft OD from 2⅛" to 1⅞" with one pass using a cross slide. Unit production rate rise 50-65%.

ADAMAS Dex-A-Tool and Grade 434 triangular insert turning vibrator shaft OD from 4⅛" to 3⅞" with one tool, and from 3⅞" to 2⅛" simultaneously with the second tool. Production rate rise 50-65%.



ESSICK Vibrating Compactor . . . One of the many pieces of heavy construction equipment machined with Adamas Carbide Dex-A-Tools and throwaway inserts.

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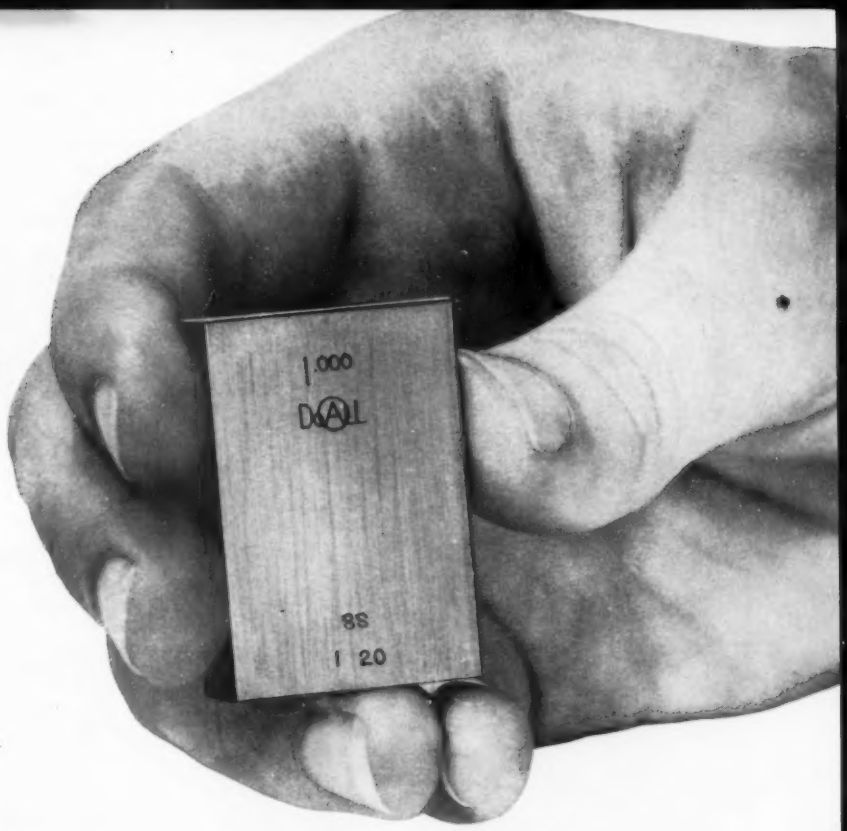
PROGRESSIVE CARBIDE USERS SELECT BY ***Performance*** — NOT HABIT!

DoALL tells how Lindberg equipment helps produce stainless steel gage blocks



For the DoALL Company, Des Plaines, Illinois, heat treatment of their Stainless Steel Gage Blocks was a most formidable problem. For lasting accuracy these blocks require extremely hard, wear-resistant surfaces, free from growth or shrinkage, as provided by nitrided stainless steel. Case depth must be controlled accurately and the core maintained at full toughness free of stresses. DoALL found the answer to this problem with a Lindberg Gas Fired Vertical Cyclone Tempering Furnace with a Nitriding Retort.

Norman Silver, Chief Metallurgist, and Lindberg Vertical Tempering Furnace at DoALL Company.

NORMAN SILVER, Chief Metallurgist says, "Our Lindberg equipment supplies the uniformity of heat distribution and the fast accurate control that is needed for the exacting requirements of our product. The furnace responds to control almost instantaneously and maintains the temperature within plus or minus 5°. Its 38" diameter by 36" depth handles 200 to 300 pound loads for the desired production. Results obtained have satisfied us completely with this, the latest of our Lindberg furnaces".

Lindberg provides the most complete line of heat treating furnaces, fuel fired or electric, large or small, for every heat treating requirement. Your Lindberg Field Representative (see your local classified directory) will be glad to consult with you on your heat treating requirements or write us direct. Heat Treating Furnace Division, Lindberg Engineering Company, 2447 West Hubbard Street, Chicago 12, Illinois.

Los Angeles plant: 11937 S. Regentview Avenue, Downey, California. In Canada: Birlefco-Lindberg Ltd., 15 Pelham Ave., Toronto 9, Ont. Also, Lindberg plants in Argentina, Australia, England, France, Italy, Japan, South Africa, Spain, Switzerland and West Germany.

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with one automatic machine

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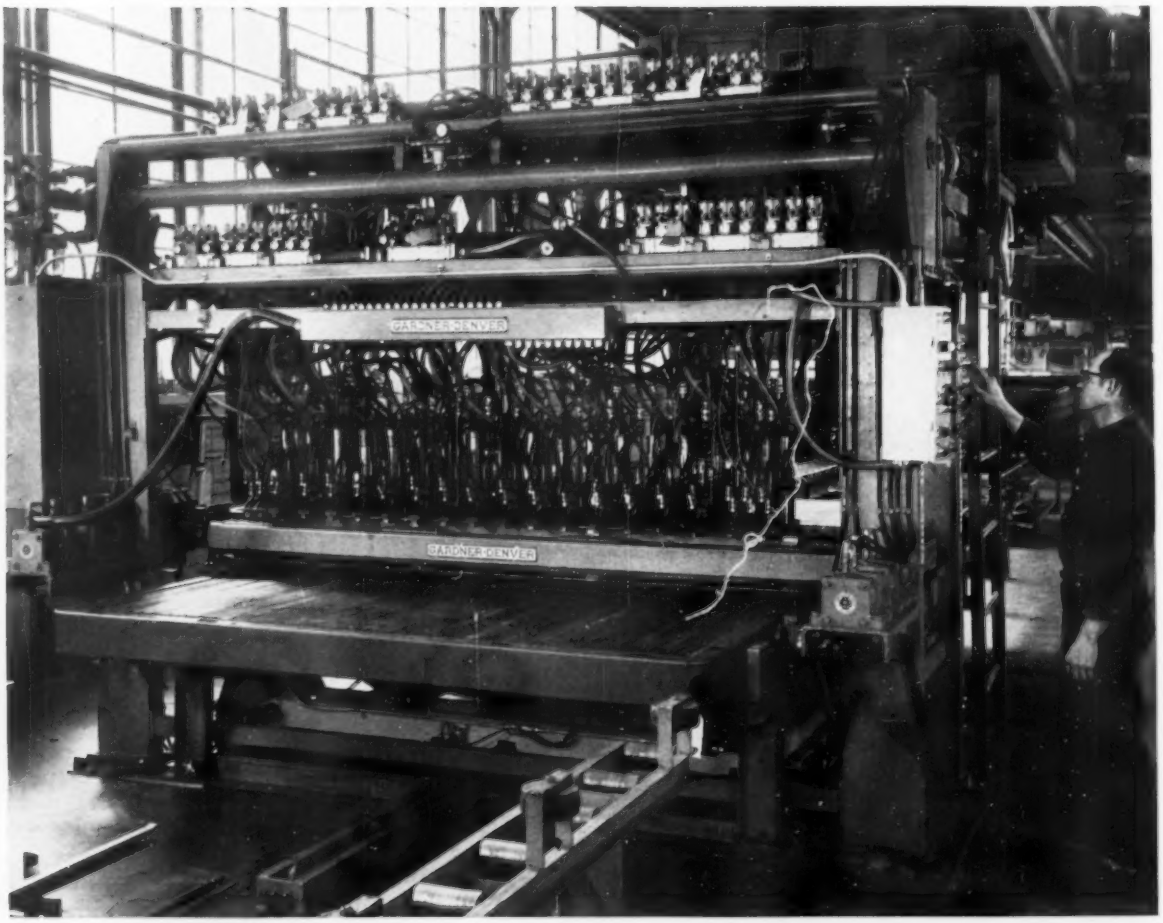
This is typical of how Gardner-Denver custom-designs production machines to automate any drilling or fastening job—saving time and money. For details, contact your Gardner-Denver air tool specialist or write for information.



Gardner-Denver production machine drills wood and metal truck body—sets ¼" x 2¼" self-tapping screws automatically at rate of 4560 per hour.

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More Milling Possible...
Milling More Profitable
with FUTURMILL

and a handful of carbide blades

Futurmill's indexable milling cutters converted so many *slow and expensive* machining methods to *fast, low cost* operations, that they established the value of "indexable tooling" . . . recognized as one of today's most important contributions to metalworking progress.

1. Lower cost metal removal

Futurmill takes the burden out of milling with inexpensive indexable carbide blades. No need to remove the cutter from the machine . . . no more cutter grinding and no more delays and lost production time. Index a Futurmill quickly and accurately, right on the machine. Eight times per blade with negative rake cutters and four times with positive. Futurmill's precision ground blades get the finest finish obtainable and more metal removed per cutting edge.

2. Plenty of muscle for any job

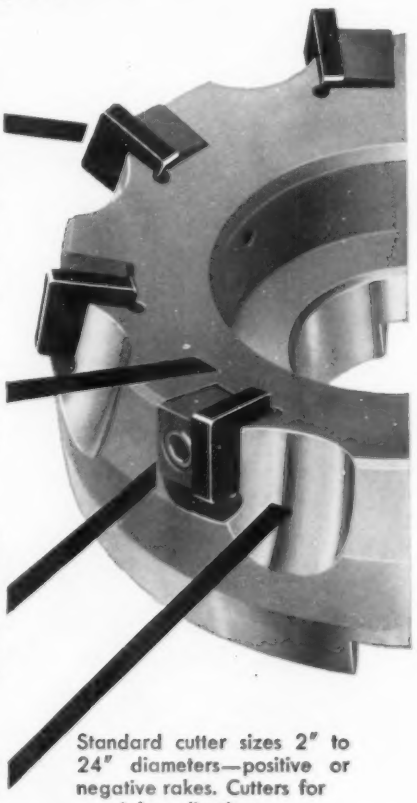
The cutter body is a solid one piece construction of heat treated alloy steel . . . not only the most rigid cutter built . . . but precision built.

3. Protection for the cutter body

The case hardened wedges behind the blades absorb the damage in case of an accident and save the cutter body . . . cutting down expense and lost production time for cutter repair or replacement . . . reducing inventory investment. With just a few extra wedges you're back in production.

4. Unobstructed chip clearance

Huge chip pockets in front of the blades direct the chips ***out and away*** from the cut—critical on steel applications and on deep cuts.



Standard cutter sizes 2" to 24" diameters—positive or negative rakes. Cutters for special applications.

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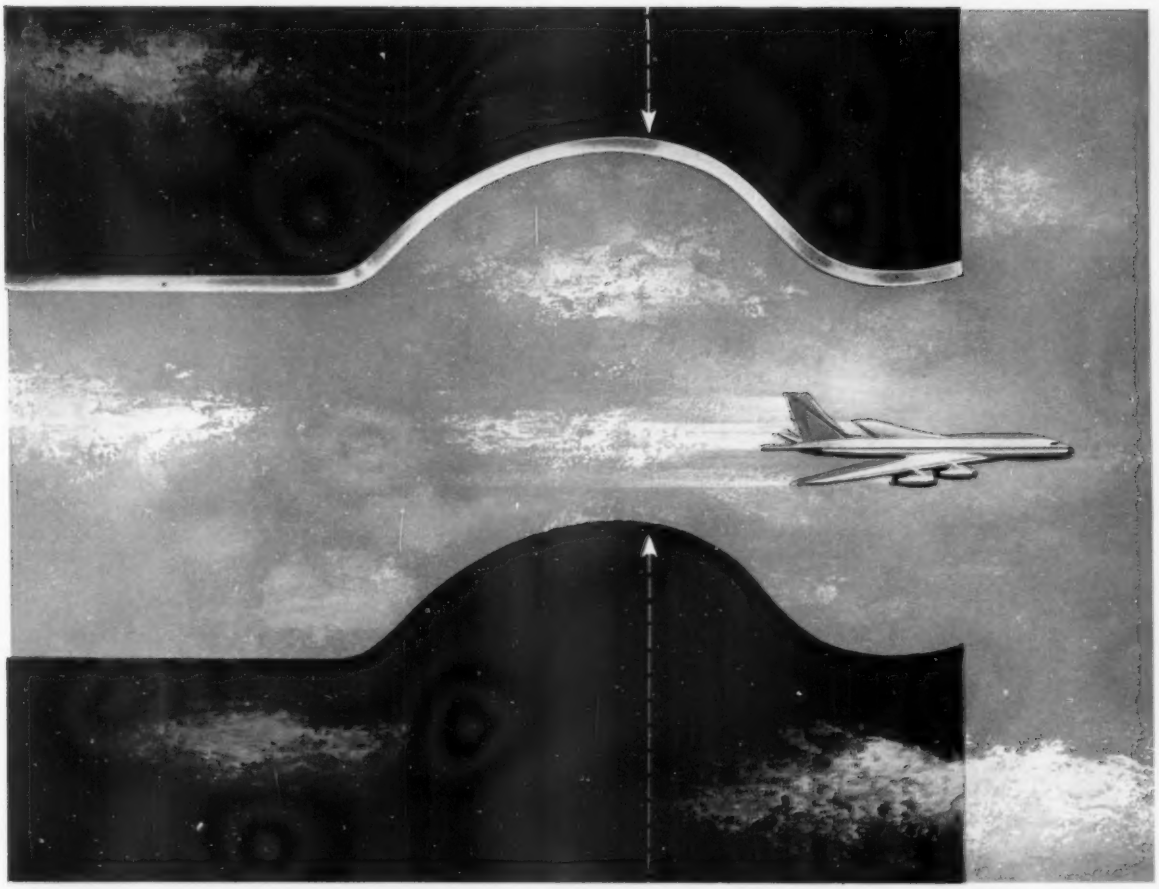

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Your EPON® RESIN tooling formulator can help you

Tools and dies made of tough but easy-to-handle Epon resin can save you up to two thirds in time, one third in cost! Your tooling resin formulator will show you how Epon resin formulations are saving time and money—*right now*—in applications such as:

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IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Toronto

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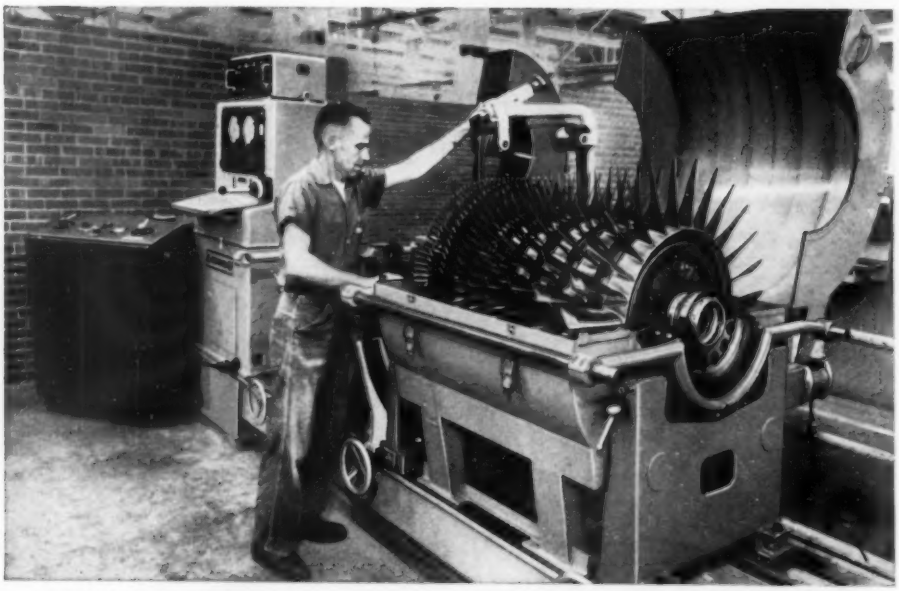

American Airlines' Boeing 707 Jet Flagships have exceptional operational dependability.

Senior Mechanic installs jet engine compressor in a Schenck Balancing Machine.

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American Airlines is "—very pleased with the outstanding results achieved with the two Schenck balancing machines we use."

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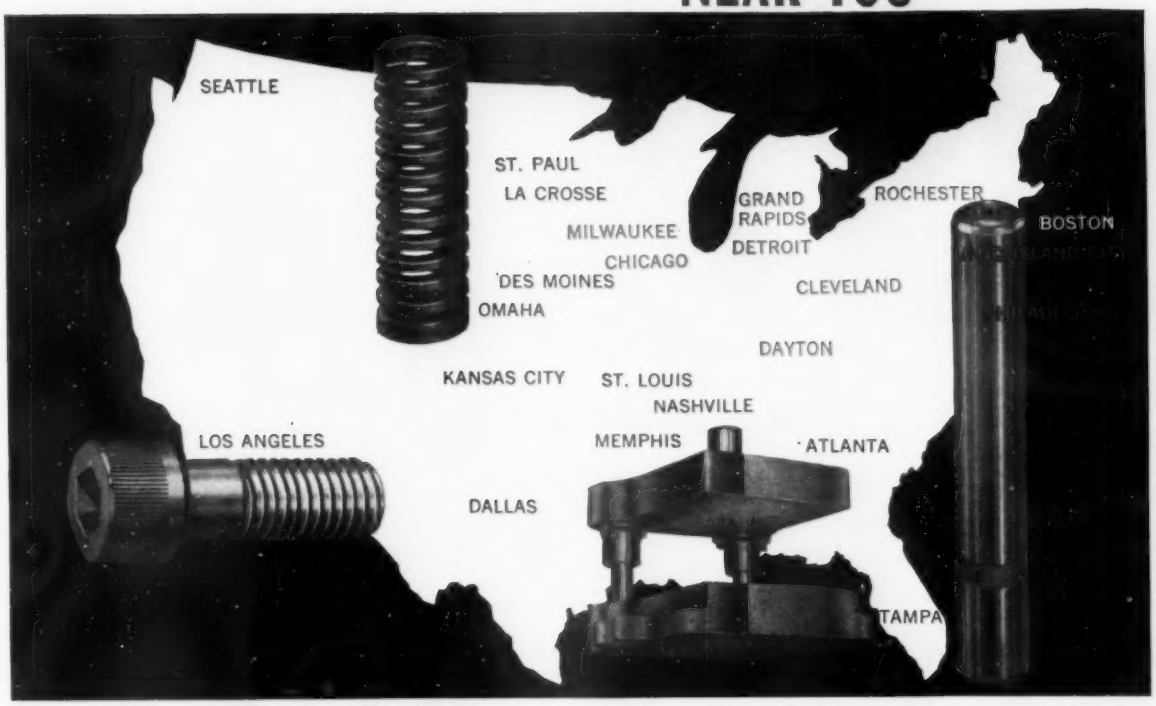

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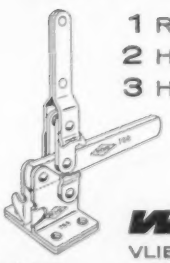

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The new Allegheny Ludlum STEELECTOR Program does virtually just that. Special Data Stock Lists (18 of them) for each STEELECTOR Grade specify the complete necessary range of sizes and shapes available that will suit virtually all applications. They also list the working hardness of typical applications, temperatures for hardening, tempering, and annealing, plus other data.

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The colorful Tool Steel STEELECTOR Booklet gives complete details of the program, explains the Data Stock Lists, and includes the three STEELECTOR Cards. Ask your Allegheny Ludlum sales representative for your copy, or write: ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. TE-10.***

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THAT YOU INVESTIGATE . . . AND WITNESS A DEMONSTRATION OF THE ALL-NEW

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Ask for a demonstration.

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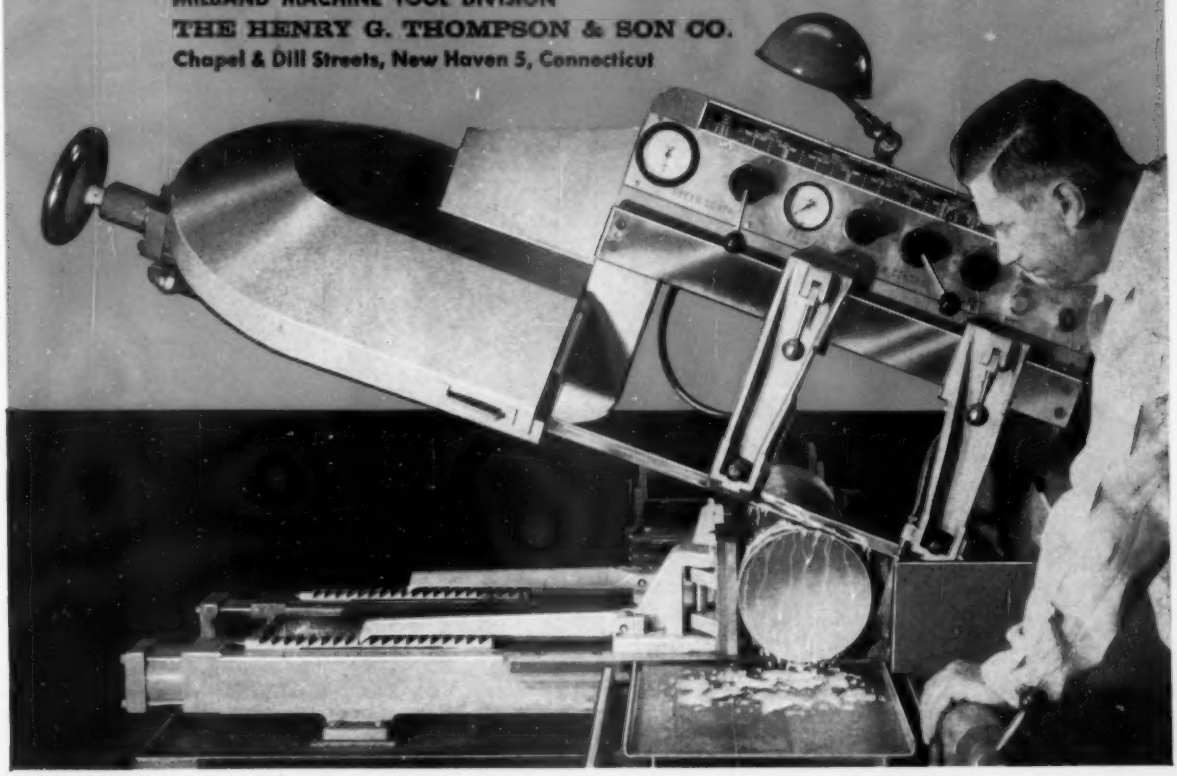
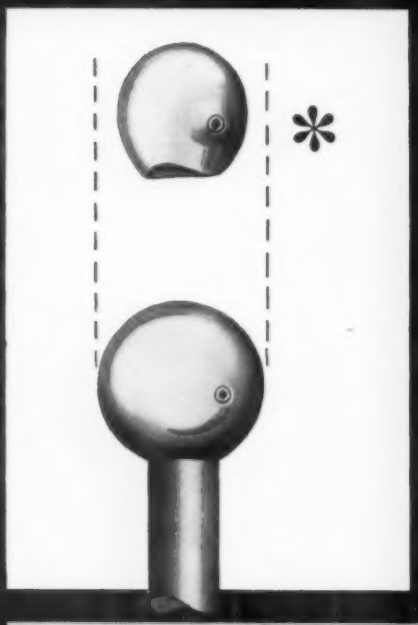
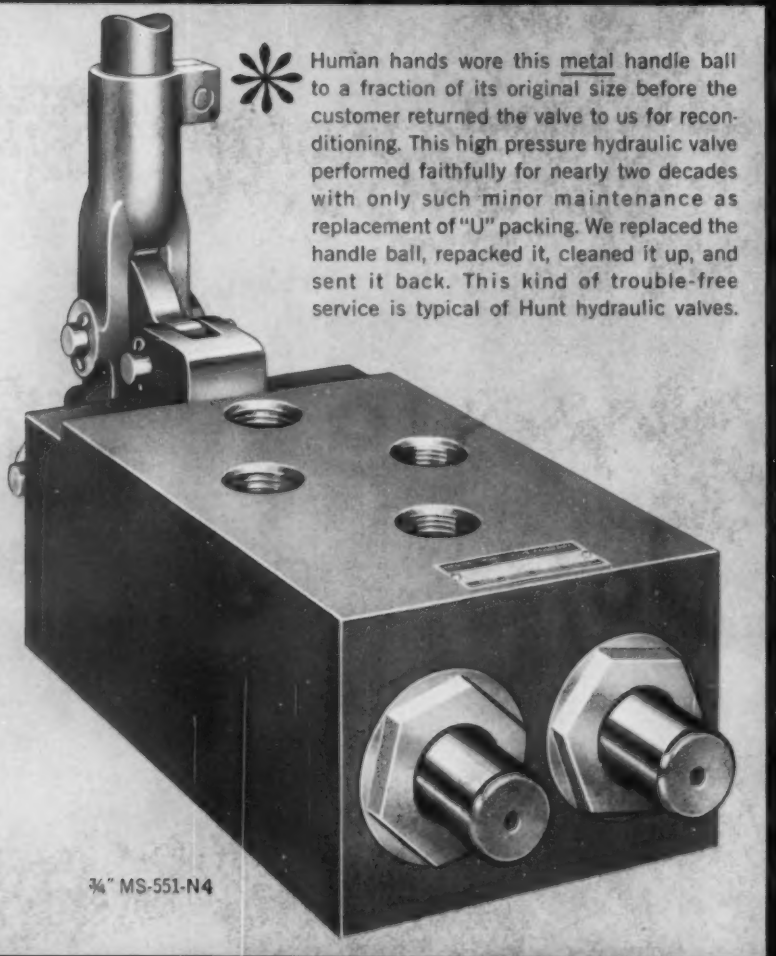


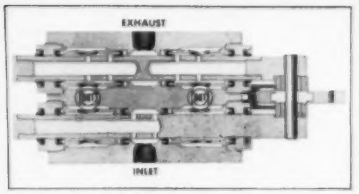


after 17 years... replacement parts ***one handle ball!***



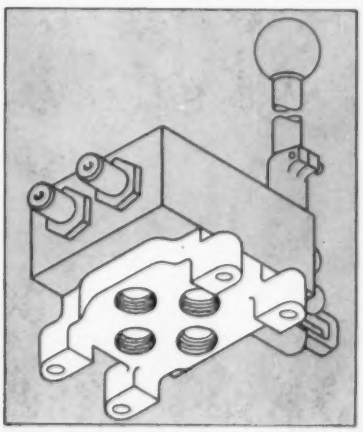
Human hands wore this metal handle ball to a fraction of its original size before the customer returned the valve to us for reconditioning. This high pressure hydraulic valve performed faithfully for nearly two decades with only such minor maintenance as replacement of "U" packing. We replaced the handle ball, repacked it, cleaned it up, and sent it back. This kind of trouble-free service is typical of Hunt hydraulic valves.

¾" MS-551-N4



The Higher the Pressure The Tighter the Seal

Cross-section view shows Hunt system of "U" packing as opposed to "metal to metal". "U" packing provides zero leakage on water hydraulic service.



Sub-Base Mounting Simplifies, Speeds Up Maintenance

New sub-base mounting is now available on all Hunt hydraulic valves. Easy, quick replacement for maintenance with no disconnecting of pipes.

HUNT HVC

HUNT VALVE COMPANY DIVISION OF IBEC SALEM, OHIO

Quick-As-Wink AIR & HYDRAULIC CONTROL VALVES

FOR THAT EXTRA EDGE IN PRODUCTION!

3½ TIMES MORE END MILL PRODUCTION with the New B&S Thriftmill® in Competitive Shop Tests!

20% Lower Initial Cost, Superior Microfinish and Less Downtime also Proved using new B&S Thriftmill.®

TEST DATA

MATERIAL:

MATERIAL: A1S1-D3 oil hardening tool steel. Hardness, Rockwell C-18.

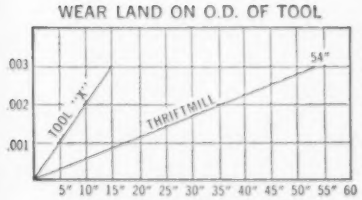
BOTH END MILLS

½" Dia., 4 flute.

CUTTING DATA

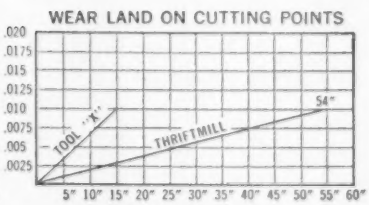
	RPM	SFM	CHIP LOAD	TABLE FEED	DEPTH CUT	WIDTH CUT	LENGTH CUT
B&S Thriftmill®	325	43	.00125	1⅝"	¼"	½"	**54"**
BRAND "X" End Mill	325	43	.00125	1⅝"	¼"	½"	**15"**

WEAR LAND ON O.D. OF TOOL



LINEAR INCHES CUT

WEAR LAND ON CUTTING POINTS



LINEAR INCHES CUT

MICROFINISH AFTER TESTS

B&S Thriftmill, bottom of slots, RMS 35.

B&S Thriftmill, sides of slots, RMS 30-38.

BRAND "X" End Mill, bottom of slots, RMS 70-100.

BRAND "X" End Mill, sides of slots, RMS 40-60.

The initial economy of the new B&S Thriftmill, together with the proven production benefits engineered into this fine tool, gives a competitive advantage to all B&S Thriftmill users. Now available in 2 flute, 4 flute, single and double end.

There are 1065 different "standard" off-the-shelf B&S end mills to choose from. End wonder, worry and wait—take advantage of B&S tooling superiority and speedy service—call your B&S Distributor now.

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HIGH SPEED STEEL CUTTING TOOLS

NELCO
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There are

MANY REASONS WHY...

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HORIZONTAL METAL CUTTING BAND SAW

...is for you!

Yes it's hard to believe, yet true! This completely new Model 14A "Big K" incorporates many cost saving features which result in cutting capacity and ability far in excess of any other cut-off method of this kind. It provides convenience and versatility not found in other metal cutting band saws.

Facilities for test runs of your material on the "Big K" are at your disposal. Let us know about your production cut-off problems. We'll show you how better quality production can be planned more efficiently at far less tool cost. No obligation, of course.

MACHINE TOOL DIVISION
Kalamazoo Tank & Silo Company

540 Harrison St.
Kalamazoo
Michigan

1. *POSITIVE CUTTING PRESSURE*
First cut-off machine to use force feed of frame to maintain correct cutting pressures.

2. *CLOCKWISE BLADE DIRECTION*
A complete hydraulic blade drive permits driving blade to enter cut with least shock for longer life.

3. *FULLY POWERED FOR PEAK EFFICIENCY*
The blade is driven by a 7½ HP motor through fluid drive. The machine is controlled by 1½ HP motor.

4. *LARGE CAPACITY*
Full 14" x 24" rectangular capacity.

5. *BLADE SELECTIVITY*
A unique method of grooving wheels permits use of 1", 1¼" or 1½" wide blades.

6. *BLADE SPEED*
Infinitely variable hydraulically driven 40 to 450 FPM.

7. *PIVOT BAR*
The frame of machine rides on pivot bar housed in Timken bearings.

8. *HYDRAULIC TANK CAPACITY*
A 75 gallon tank is provided to insure low temperature operation for trouble-free service.

9. *BLADE CLEANING BRUSHES*
Double opposed rotary power driven blade brushes provide clean tooth gullet for efficient cutting.

10. *CONVENIENT MACHINE HEIGHT*
The bed, take-off table and bar feed are 36" from the floor to reduce operator fatigue.

11. *PUSH BUTTON CONTROLS*
All controls are centered at a control console away from operation of frame or blade for safe, convenient operation.

12. *CLEAN, RUGGED DESIGN*
Rugged heavy duty construction along with clean lines of design permit easy servicing and trouble free operation.

13. *LARGE CAPACITY COOLANT TANK*
A 15 gallon coolant tank and convenient chip disposal drawer minimize the clean out times and provide ample coolant delivery.

14. *PRECISIONED MACHINED GUIDE ARMS —*
And Guide Arm Bar . . . provide rigged blade guide to insure accurate cut-off.

15. *BLADE MOUNTING*
Kalamazoo continues to provide minimum effort for blade changes by mounting blade from top.

A NEW *"COMPACT"* HITS THE MACHINE TOOL FIELD . . .

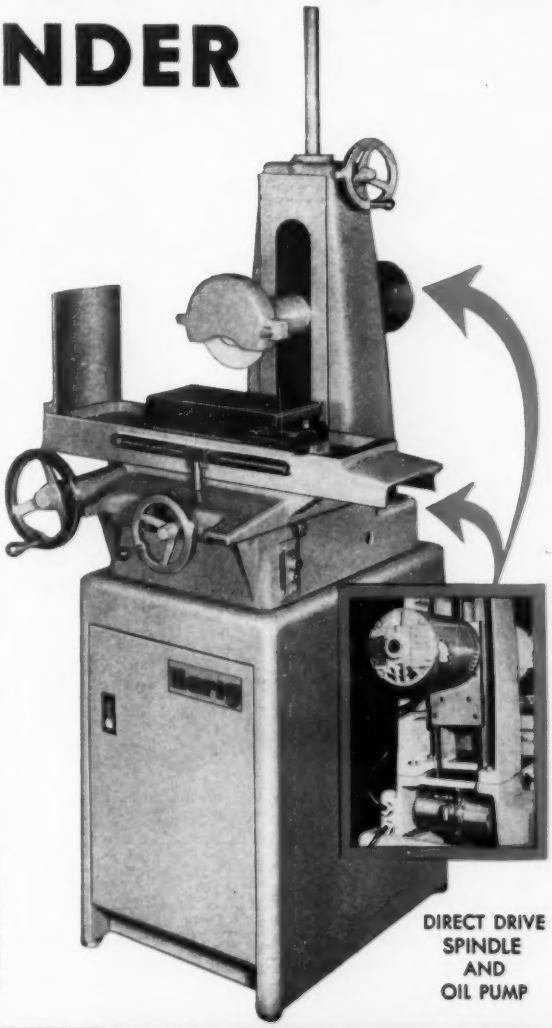
THE NEW HARIG 612 SURFACE GRINDER

with

* **Automatic forced lubrication**
  goes into operation as soon as machine is started — triples life of the ways and preserves original accuracy.
* **Direct drive spindle**
  increases power . . . reduces vibration . . . no V-belts to replace.
* **Your choice of right or left hand longitudinal feed**

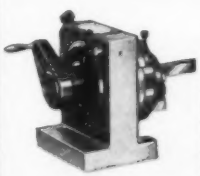
All Standard Equipment

The new 612 represents a break-thru in design and construction whereby Harig now offers industry a low-cost, precision surface grinder loaded with features usually found only on expensive models. Easy to operate . . . requires little maintenance . . . built with the precision quality you expect from Harig.



DIRECT DRIVE SPINDLE AND OIL PUMP

GET ALL THE FACTS . . .
Write for brochure on the Harig 612 Surface Grinder



HARIG'S NEW IMPROVED GRIND-ALL FIXTURE

Easily grinds irregular shaped perforators concentric with shank within ±.0001 accuracy. Also can be used as milling, boring and inspection fixture. NEW ATTACHMENTS: Radius Dresser Arm and Ball Seat Punch Adapter. (Write for new Grind-All Brochure.)

Harig
Manufacturing Corp

5745 W. HOWARD ST. • CHICAGO 48, ILL.

A new standard of accuracy...

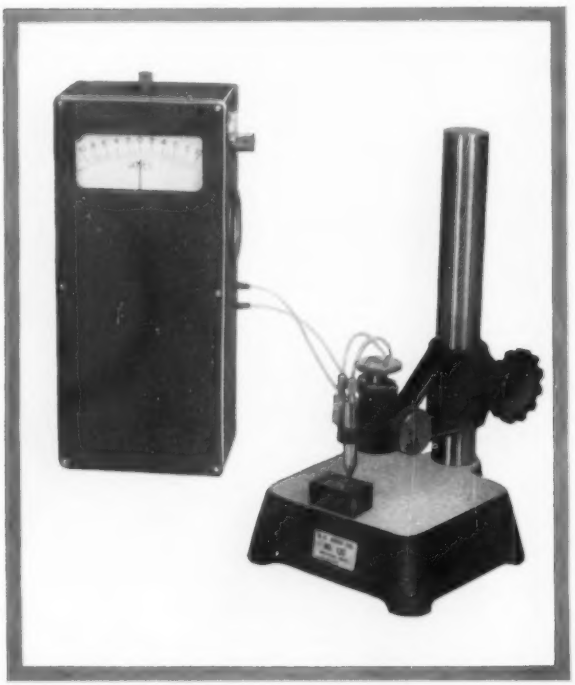
ACCU-FLOW* by AMES

B. C. Ames has perfected a new concept in air gauging . . . ACCU-FLOW . . . which offers extremely fine measurement and unusual stability.

Key feature of the ACCU-FLOW system is a new patented nozzle which provides a high degree of sensitivity and excellent linearity.

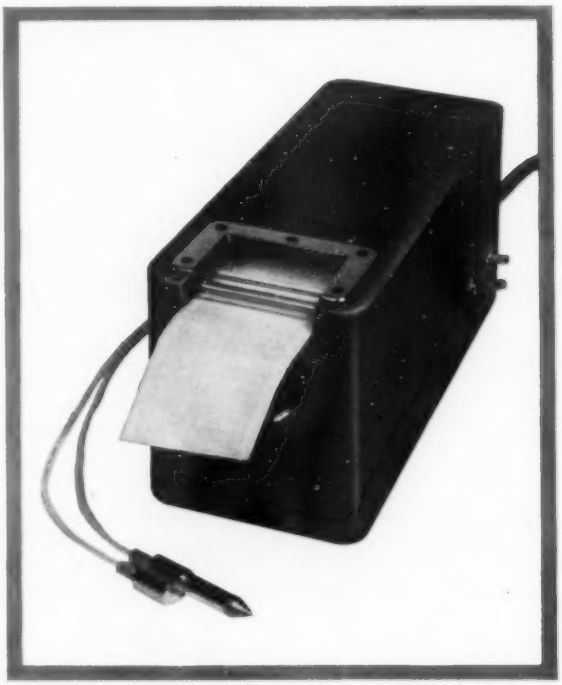
ACCU-FLOW is the answer to many measuring problems that were once considered impossible to solve. The ACCU-FLOW system includes: *gauges that provide a continuous record of wire diameter, and determine the roundness of balls or shafts . . . a contour tracer that permanently records contours in greatly enlarged scale . . . automatic sorting gauges . . . a non-contact follower gauge* and *a gauge for measuring grinding variations.*

For complete information on the entire line of AMES air gauging equipment, write for new ACCU-FLOW folder.



AG5 ACCU-FLOW Air Gauge

The versatility of ACCU-FLOW equipment is indicated by Model AG5. Adaptable to less than five millionths of an inch tolerances, the AG5 can be used as a contact comparator, flatness comparator, depth gauge, hole gauge, continuous non-contact measurer or comparator, and a grinding gauge.



AG7 ACCU-FLOW Air Gauge Recorder

The AG7 Air Gauge Recorder gives you a permanent record of continuous measurement. Measurements are recorded on a 2"-wide chart paper by a Sanborn "hot needle." As in other ACCU-FLOW models, the nozzle may be placed a considerable distance from the recording unit.

*Trademark of B. C. Ames Co.

Representatives in Principal Cities

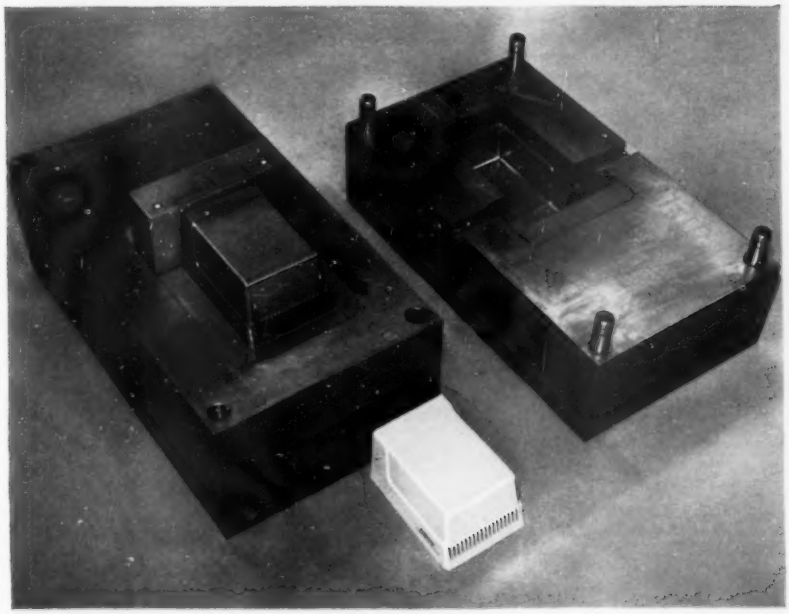
B.C. AMES CO. *30 Ames Street, Waltham 54, Mass.*

Canadian Representative—H. C. Burton Co. Ltd., Hamilton

MANUFACTURERS OF MICROMETER DIAL INDICATORS AND GAUGES

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.



LUSTRE-DIE does smooth job in molding can-opener housing

Bethlehem Lustre-Die tool steel, which is furnished pre-heat-treated in bars, recently turned out a top-quality molding of high-impact polystyrene at Cepco Plastics Co., St. Louis. The plastic-injection mold, made by Lambert Engineering Co., produced a sturdy, attractive can-opener housing for Swing-A-Way Manufacturing Company.

Here are the reasons why Lustre-Die made such a hit: 1. It saved time, because no heat-treatment was required. 2. It was easier to machine than other pre-hardened grades which were previously used. 3. It polished beautifully, and imparted a high sheen to the finished part.

An electric-furnace steel with a well-balanced basic analysis, Lustre-Die is ideal for working with plastic because it takes a glossy polish. This tool steel also has something extra: a special alloy fortification which further increases its depth of hardenability and enhances its mechanical properties. It is heat-treated by oil-quenching and tempering at the mill, and is furnished ready for machining and polishing. Careful manufacture and quality control insure its freedom from porosity.

You can take our word for it—Lustre-Die is just what you need for a good plastic-molding job. For full details, and prompt delivery, get in touch with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Straighten tools while they are hot

Though seldom recognized or appreciated, straightening is an essential part of the quench and temper hardening operation on long, slender tools. The correction of warpage which occurs either in heating tools to the quenching temperature, or from stresses generated in the quench, must be done during heat-treatment. Only minor straightening can be done on hardened tools at room temperature after the hardening operation is complete.

For example, the major straightening on a long rectangular shear blade must be done during quenching. The heat-treater learns by experience at what point the quench can be interrupted so that straightening can be performed. This point varies with the grade of tool steel, and the size and shape of the shear blade. Straightening usually is performed by bending the tool slightly on a press (so-called gag straightening).

Small amounts of additional straightening can be accomplished when the tool is at the tempering temperature. Or, if necessary, this can be done by reheating to a point just below the final tempering temperature.

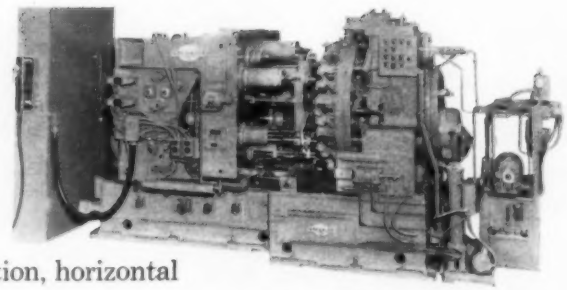
Minor mechanical adjustments in the final assembly of tools and components are often made by peening the concave surfaces with a hand hammer. This should be done cautiously to avoid spalling or cracking. However, it is preferable to straightening by cold-bending.

New Booklet on Oil- and Air-Hardening Grades

We have a new illustrated booklet on oil- and air-hardening tool steels. It presents essential data about the BTR, Air-4, Lehigh H, and A-H5 grades. For your copy, write to Publications Dept., Bethlehem Steel Co., Bethlehem, Pa. Ask for Booklet No. 532.

Use Reader Service Card, CIRCLE 57

Return on money

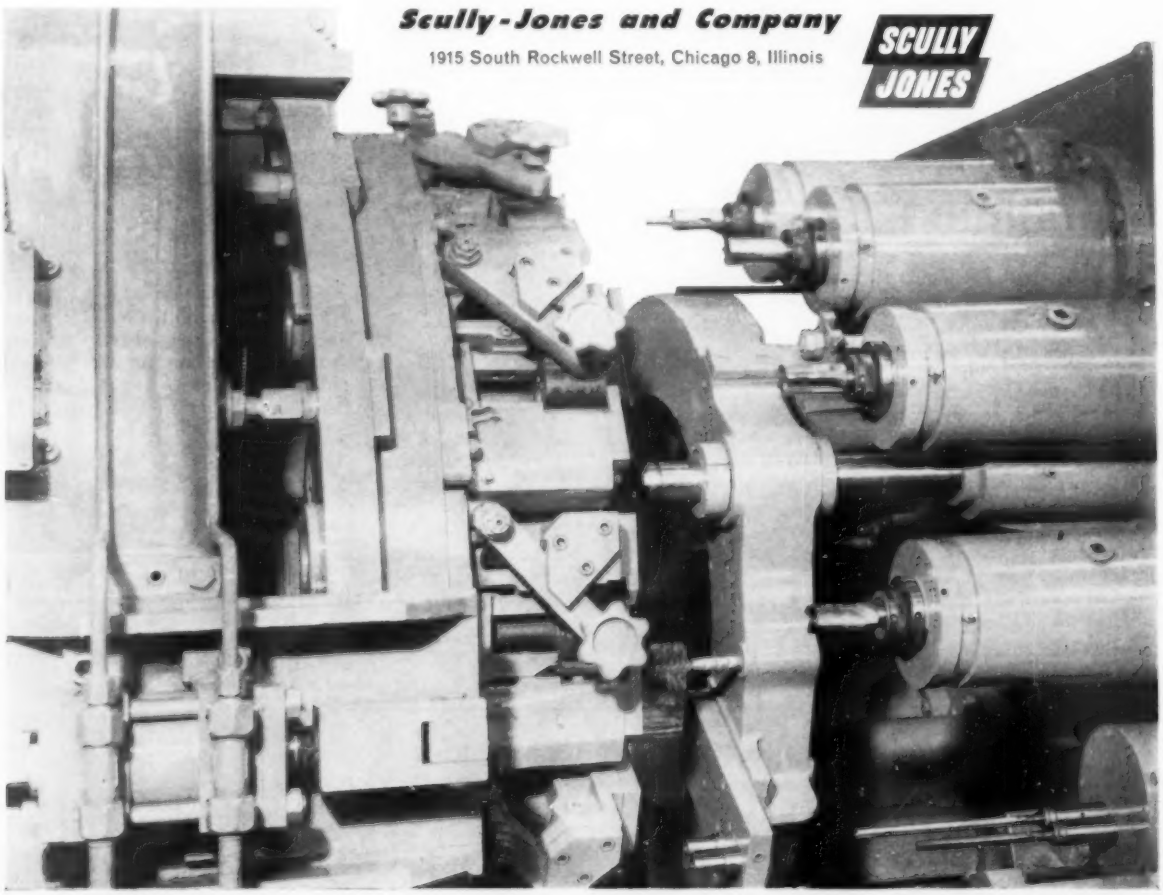


invested in multiple-spindle machines often is controlled by *tooling*. Greenlee engineers recognize this — specified quick-change, pre-set tooling as original equipment on this 12-station, horizontal indexing machine. It operates at close to 100% efficiency, drilling, chamfering, boring, and reaming pump bodies at 97 per hour. Cycle time per piece is 37.2 seconds. Depth of bore is held to ± .001″, ream hole size to ± .0005″. Scully-Jones "Better-Hold" chucks speed tool changes and provide a rigid, concentric drive for the boring tools (not piloted). Tools are preset outside the machine. Patented "Lock-and-Eject" nut on end of chuck turns on ball bearings. The operator just twists it to quickly unseat the tool. Opposite rotation produces a powerful, self-centering fit that assures high accuracy and long tool life. Ask your Scully-Jones distributor or representative for details.

Scully-Jones and Company

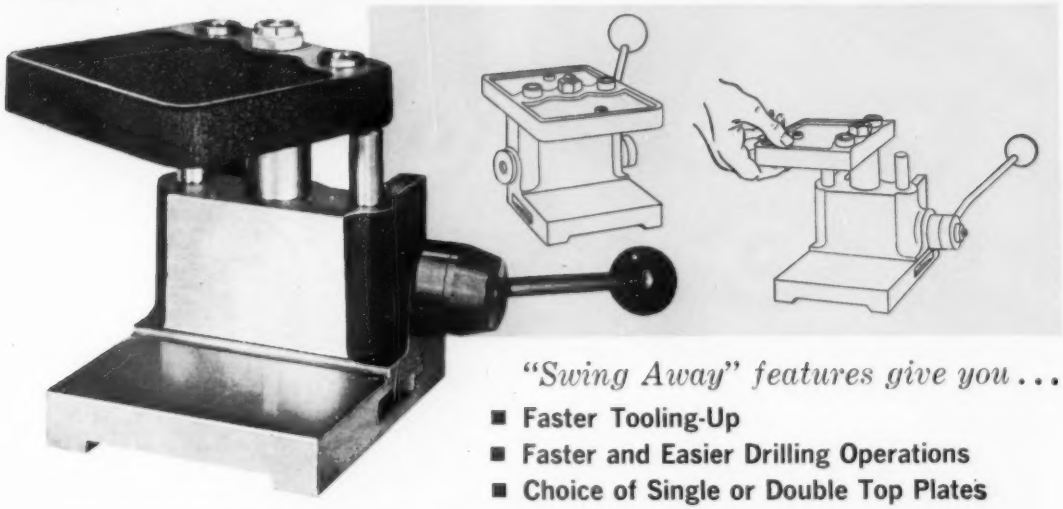
1915 South Rockwell Street, Chicago 8, Illinois

SCULLY JONES



tool quickly for long or short runs!

ABC LIFT SWING DRILLING FIXTURES

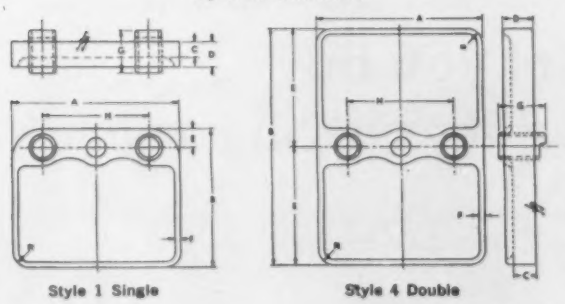


"Swing Away" features give you . . .

- **Faster Tooling-Up**
- **Faster and Easier Drilling Operations**
- **Choice of Single or Double Top Plates**

INTERCHANGEABLE TOP PLATE ENGINEERING DATA

Top Plate Dimensions



Style 1 Single — Style 4 Double

Top Plate Sizes

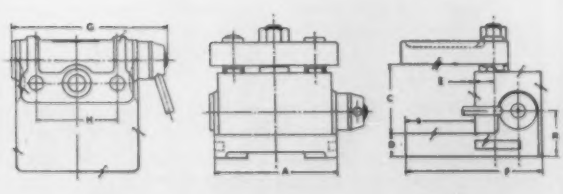
Top Plate Style	Top Plate Number	A	B	C	D	E	F	G	H	R
1	2201	2⅛	2⅛	½	½	7/16	—	¾	1½	5/16
4	2204	2⅛	3⅛	½	½	1 1/16	—	¾	1½	5/16
1	3201	3⅛	3 7/16	½	½	⅛	—	1	2½	⅜
4	3204	3⅛	5⅛	½	½	2 13/16	—	1	2½	⅜
1	4201	4¼	3¼	½	¾	⅛	3/16	1	2½	½
4	4204	4¼	6¼	½	¾	3⅛	3/16	1	2½	½
1	5301	5½	5	¾	1	⅛	3/16	1⅛	3½	⅝
4	5304	5½	8¼	⅜	1	4⅛	3/16	1⅛	3½	⅝

Larger sizes and other style single top plates available.

IMPORTANT: When ordering Complete Assembled Lift Swings, specify first 3 digits of Base Number and 1 or 4 to indicate the style of Top Plate desired. EXAMPLE: LS-3221 = 3220 Base with 3201 (Style 1) Top Plate.

FIXTURE BASE ENGINEERING DATA

Fixture Base Dimensions



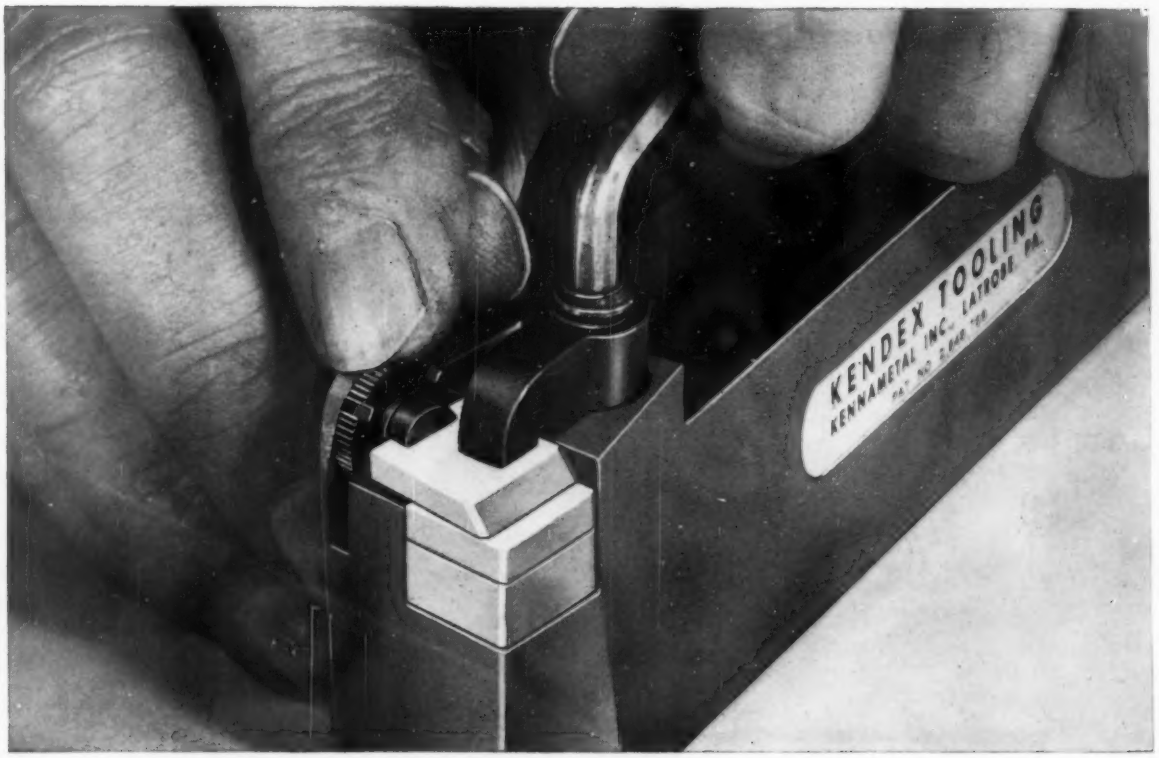
Top View (Top Plate Removed) — Front View — Side View

Fixture Base Sizes

Lift Swing Base Number	A	B	C	C	C	D	E	F	G	H	R
			Shut	suggested max. clamp	Open						
2220	2⅛	1⅛	1½	1¾	2¼	1	½	3⅛	3¼	1½	1 9/16
3220	3⅛	2⅛	2	2⅛	3	1	⅝	4½	5	2½	1 1/16
4220	4⅛	2⅛	2½	2⅞	3½	1	⅛	5	5¼	2½	1¾
5330	5¼	3⅛	3	3¼	4⅛	1	1	6¼	6¼	3½	2
5340	5⅛	3⅛	4	4¼	5⅛	1	1	6¼	6¼	3½	2
5350	5⅛	3⅛	5	5¼	6⅛	1	1	6¼	6¼	3½	2

Larger sizes available. For tooling suggestions and complete engineering data write for Catalog LS-60-1.

ACCURATE BUSHING COMPANY
443 NORTH AVE., GARWOOD, N. J.



New Kendex* Dial-A-Breaker* permits close ganging of tools. All adjustments, chipbreaker and insert, can be made from the top of the holder.

The machine tool you buy is no better than its cutting tool

You may have looked at many ingenious machines and wizard-like controls at the Chicago Show. Perhaps you bought one . . . or are planning to . . . in the hope of increasing production, improving products or reducing costs. *But the final return on your machine investment depends upon the tooling.*

It doesn't pay to spend thousands of dollars on machines . . . then try to save a few pennies when tooling up

Whether the machine is one of the latest, high speed, numerically controlled types or an older model . . . you will make more, products and dollars, by equipping it with the BEST tools you can buy.

The best tooling is especially important for machines operated by numerical controls. Inserts must be of uniform quality for predictable service life. Toolholders must be designed for quick indexing of inserts and fast adjustment of chipbreakers . . . to minimize set-up time, improve accuracy and reduce scrap.

The new Kendex Dial-A-Breaker, shown above, is especially well suited for automated operations. Its attached, quick-adjusting chipbreaker shortens set-up time, speeds insert indexing, assures optimum chip control and eliminates the need for a different chipbreaker for every job. *Only two sizes of chipbreakers are needed to service 76 styles and sizes of holders.* The Dial-A-Breaker eliminates chipbreaker grinding, simplifies stocking.

From the versatile Kendex line, you can get the tool best for every job. There are 110 standard styles and over 400 toolholders to select from. Or, we can help you develop special heads with Kendex throwaway inserts that may permit several operations to be performed in one pass.

For maximum production, make certain you have the most productive tooling on your machines. Call your Kennametal Representative. His only job is applying Kennametal* hard carbides to tooling and specialized uses. KENNAMETAL INC., Latrobe, Pennsylvania.

*Trademark

33546

INDUSTRY AND
KENNAMETAL
...Partners in Progress

BURNERD MEEHANITE Precision Chucks

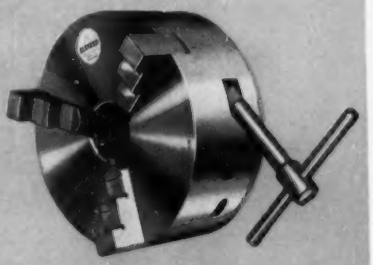
Unsurpassed in quality, precision and value!

When you buy Burnerd, you buy the best—in precision, service life and value.

Every Burnerd chuck is built to uncompromisingly high standards of accuracy. Every Burnerd chuck is *guaranteed* against defects in material and workmanship *for a period of two years*. Every Burnerd chuck is backed by the coast-to-coast sales and service organization of Clausing.

Check the wide variety of types and sizes against your requirements. Then write for a catalog and check prices—you'll be pleasantly surprised. When you invest in a Burnerd you save 20—even 30%! You get *more . . . far more . . .* with Burnerd.

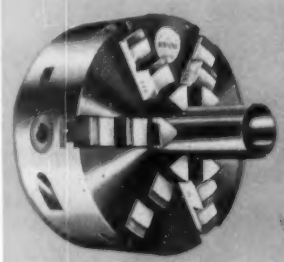
Send for literature today.



3- and 6-jaw GRIPTRU chucks

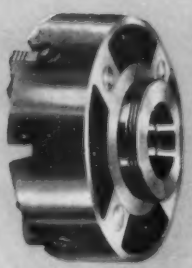
4" to 12" dia.

Concentricity within .0002" TIR!



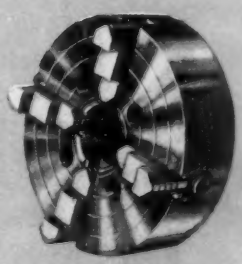
Chucking work to within .0002" precision takes but one minute. Duplicate parts are chucked to same accuracy at scroll chuck speed. Meehanite bodies. *3-pinions.* Two sets solid jaws.

Available for direct mounting to long taper or D-1 cam-lock spindles, or, for backplate mounting.



4-jaw heavy-duty independent chucks

6½" to 28" dia.

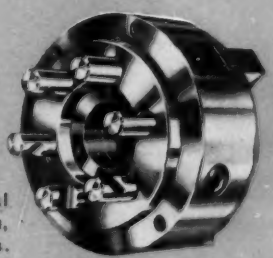


Have rugged Meehanite bodies, case-hardened ground steel jaws, large diameter case-hardened operating screws. Chucks 10" and larger have double thrust bearings.

Available for direct mounting to long taper or D-1 cam-lock spindles, or, for backplate mounting.

3- and 4-jaw universal chucks

4" to 24" dia.



3- and 4-jaw universal chucks, like Burnerd Griptru, have Meehanite bodies. Scrolls are precision machined from heat-treated alloy steel. Pinions are case-hardened nickel steel—*there are three in each chuck.* Jaws are case-hardened, ground.

3-jaw chucks available with two-piece jaws or two sets of solid jaws—for direct mounting to long taper or D-1 cam-lock spindles, or, for backplate mounting.

336

BURNERD CHUCKS

CLAUSING DIVISION

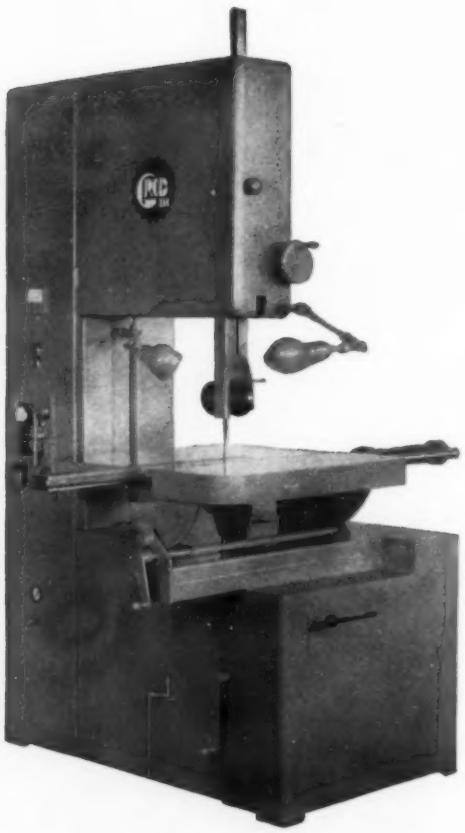
ATLAS PRESS COMPANY

10-217 N. PITCHER ST. • KALAMAZOO, MICH.

GROB SPELLS THE DIFFERENCE IN BAND SAW MACHINES

The new GROB 24" universal band saw
has all the famous GROB features:

Quality • Efficiency • Durability • Strength
Utility • Low Maintenance • Reasonable Cost



- Speeds infinite from 35-12000 FPM covers both cold and hot sawing
- Variable drive 3-speed transmission with precision rolled gears and splines transmits 15 HP
- Hydraulic table feed

See the difference demonstrated in our dealers' showrooms

or

Write GROB INC. for complete specifications

GROB also manufactures a complete line of:

BUTT WELDERS
FILING MACHINES
GEAR ROLLING MACHINES

GROB INC

GRAFTON, WISCONSIN

ANOTHER EXCLUSIVE from DoALL

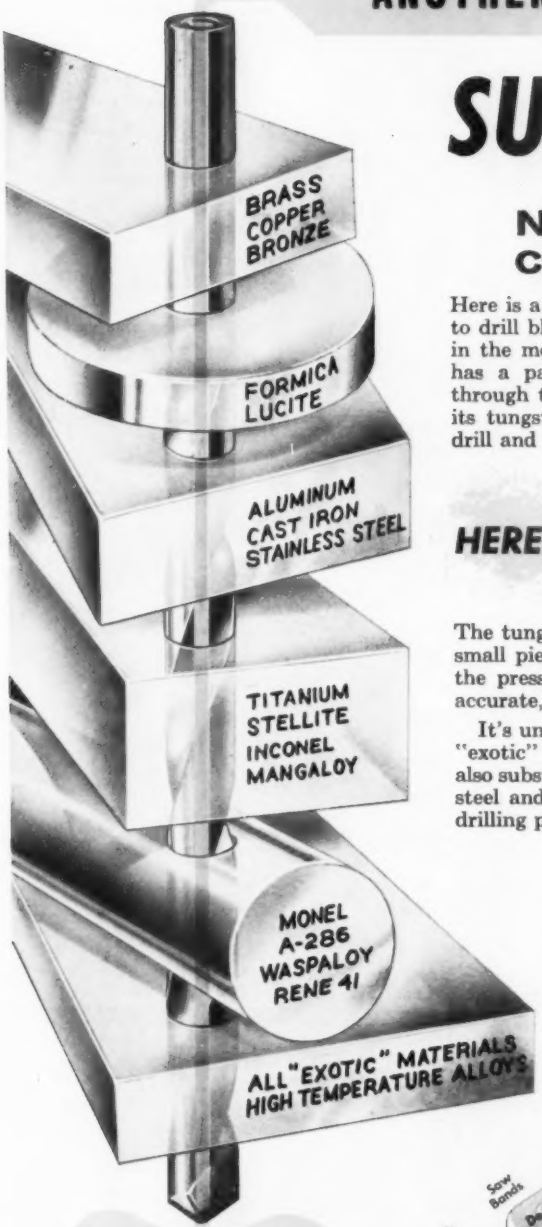
SUPER DRILLING

with

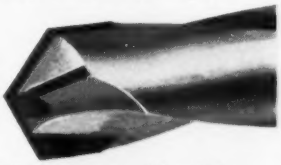
New COLD-POINT* Drill

Carbide Tipped • Patented

Here is a revolutionary new drilling concept that will enable you to drill blind, deep and through holes faster and more accurately in the most difficult of materials. The new *COLD-POINT Drill* has a patented internal cooling facility that delivers coolant through the drill, ejecting it under high pressure at the point of its tungsten carbide tip. Heat is carried away so fast that the drill and workpiece seldom reach temperatures above 100 deg. F.



HERE'S THE POINT . . .



The tungsten carbide tip has a negative rake to break chips into small pieces. These are quickly flushed up through the flutes by the pressurized coolant. Results: faster drilling; no withdrawal; accurate, superfine finished holes that often eliminate reaming.

It's unequaled in hard, tough, abrasive materials, including the "exotic" high-temperature alloys. The *COLD-POINT Drill* will also substantially increase production on aluminum, brass, stainless steel and many other materials which do not present as great a drilling problem as high-temperature alloys.

AVAILABLE IN 3 LENGTHS

COLD-POINT Drills are available through your nearby DoALL Sales-Service Store. Over 200 standard sizes, ⅛"-¾", and letter sizes A-Z, in Jobbers, Stub and Taper Lengths. Special lengths, diameters and internal threaded shanks can be furnished promptly. Also available: h.s.s. and DoALLoy† (cast alloy) tips. Prices on application.

Start cutting your drilling costs with DoALL *COLD-POINT Drills*. We invite you to try these sensational drills on your own work. Call your local DoALL Store today.

With COLD-POINT Drills

you get increased productivity at lower cost on your . . .

- Screw Machines
- Chucking Machines
- Drilling Machines
- Turret Lathes

COLD-POINT Drills can be used on any machine with hollow spindle. Any other machine can be easily adapted with a coolant-fed chuck.

*Reg. T.M.—Mossberg U.S. Patent No. 2,871,983 CT-64

†Reg. T.M.—The DoALL Company

THE DoALL COMPANY • DES PLAINES, ILLINOIS

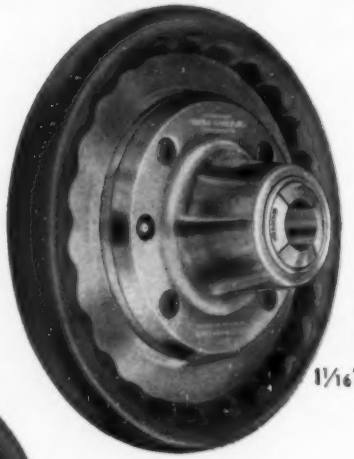
HARDINGE
ELMIRA, N.Y.

HARDINGE Sjogren Chucks

Quality at Low Cost

HARDINGE-SJOGREN Speed Collet Chucks for tool room lathes, engine lathes and grinders.

Available for Threaded Nose, Cam Lock, Taper Key Drive and American Standard Spindles.

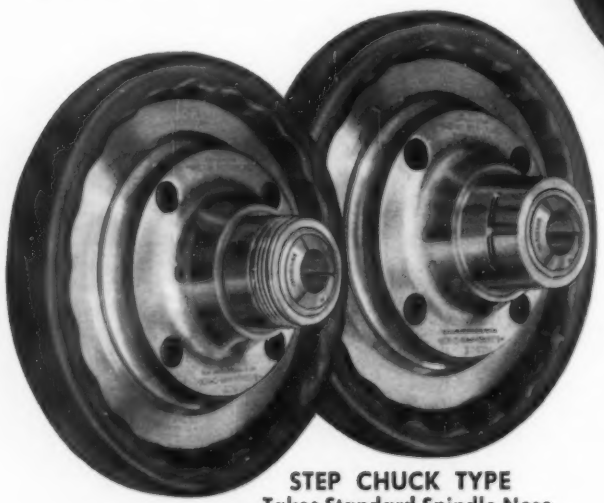


70th ANNIVERSARY 1890 - 1960 HARDINGE ELMIRA N.Y.

REGULAR TYPE

AVAILABLE IN FIVE COLLET CAPACITY SIZES

1 1/16", 1 3/8", 1 3/4", 2 1/4", 3 1/2"



STEP CHUCK TYPE
Takes Standard Spindle Nose Accessories As Used With Hardinge Precision Machines

LEVER TYPE

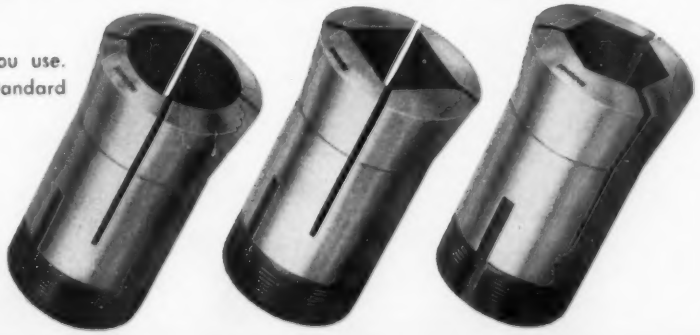
Ask Your Hardinge Representative or Local Distributor For Bulletin 88

HARDINGE
ELMIRA, N.Y.

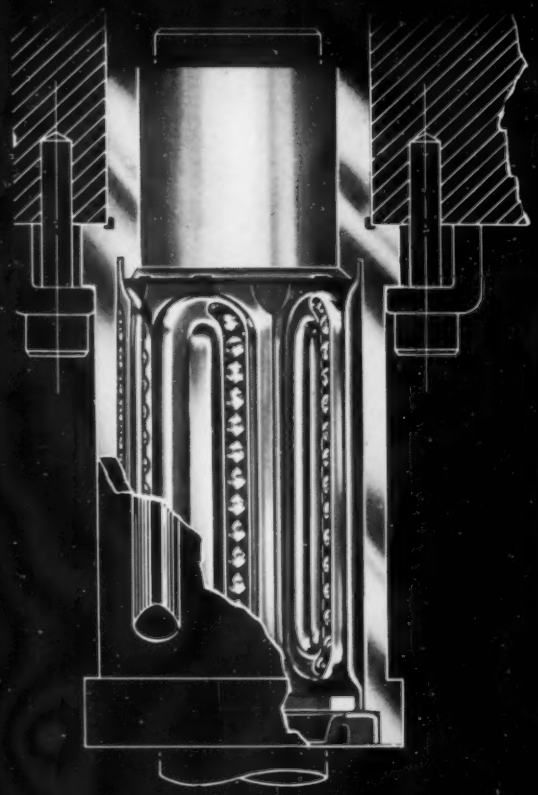
HARDINGE Low Cost Steel Collets

Maximum efficiency — Pay for only what you use. Records show that 82% of all sizes used are standard 16th sizes.

Buy only the sizes you use—Hardinge Collet stocks are available in Atlanta, Elmira, Oakland, Portland, Seattle, Hartford, New York, Philadelphia, Dayton, Detroit, Chicago, St. Louis, Minneapolis and Los Angeles. Springfield, N. J. and Toronto.



HARDINGE BROTHERS, INC., ELMIRA, N. Y. U.S.A.



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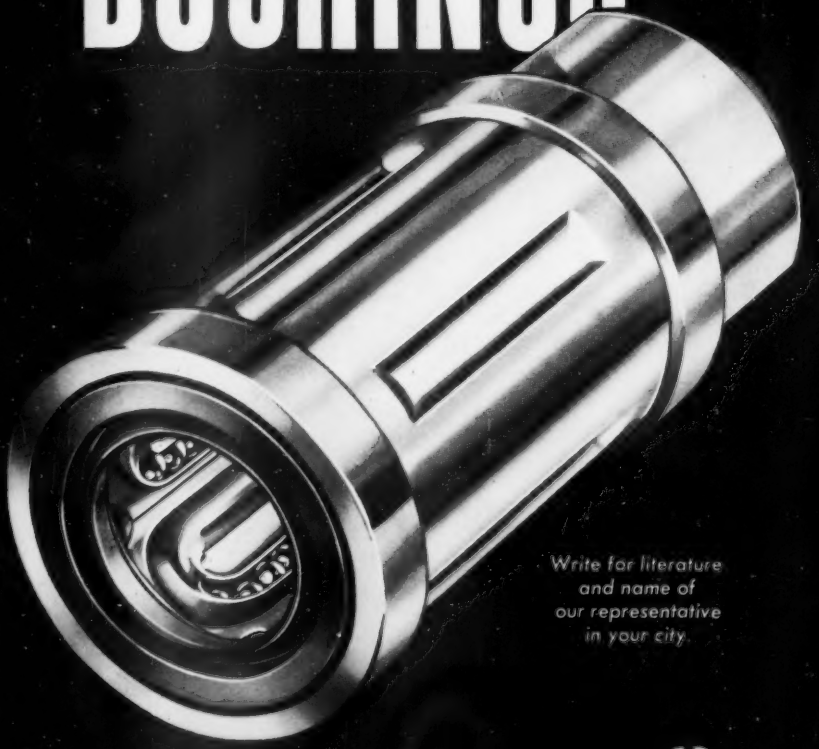

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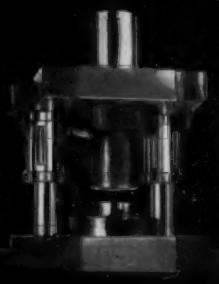

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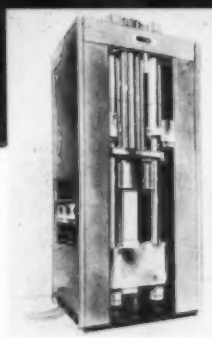

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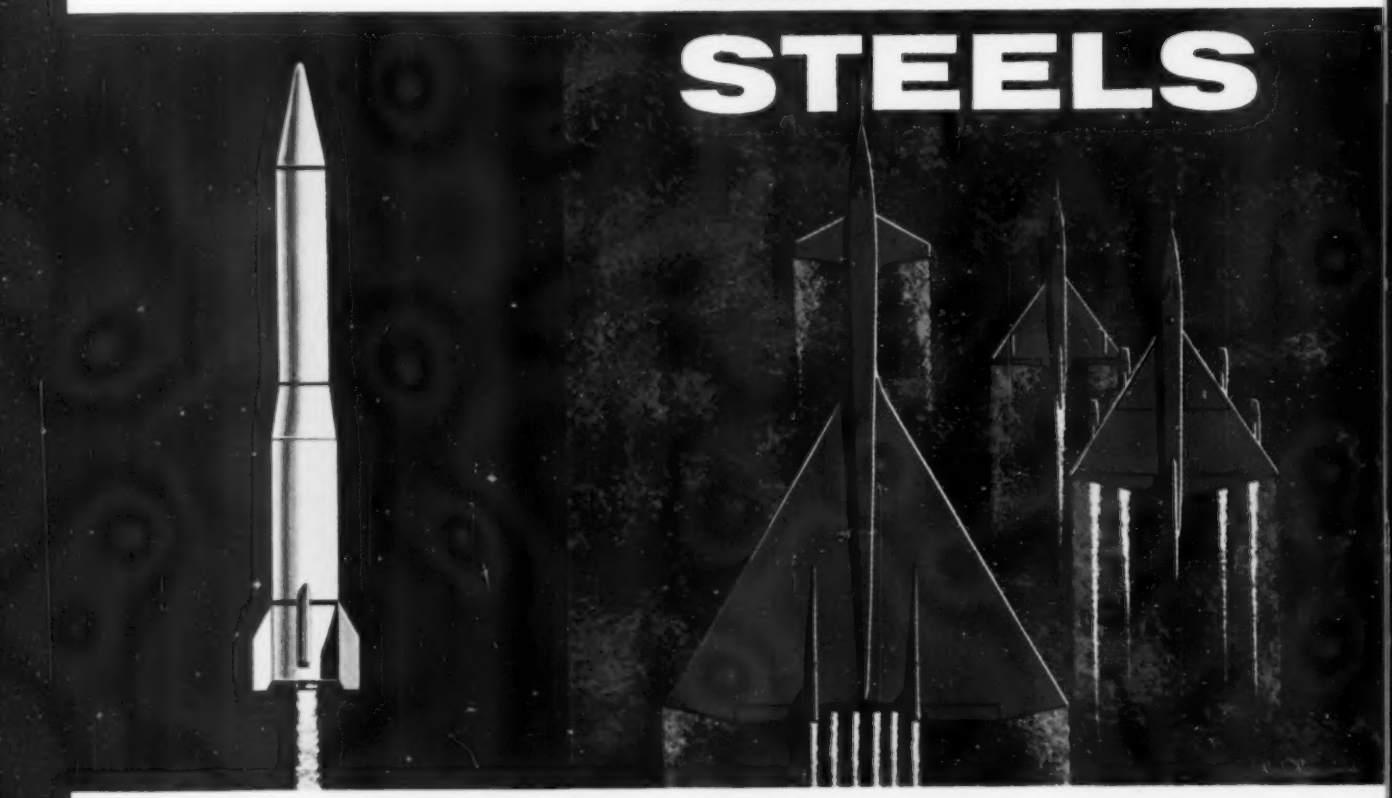

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12" square	22	10
9½" round	27	11
9" square	30	11
7" round	31	12
7" square	35	12

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The Fountain of Youth

Wouldn't you like to discover the "fountain of youth?"

Many of you are getting used to the routine of your youngsters being back in school again and the painful process of pushing them to turn off the TV and get their homework done. The learning process to many is like pulling teeth, but in it lies the true fountain of youth. Henry Ford said, "Anyone who keeps learning is young, and the greatest thing in life is to keep your mind young."

Last month, in addition to the youngsters starting to school, our 167 senior chapters and 32 student chapters kicked off their own educational season with the regular monthly technical programs. I would like to think that all of our 40,382 members were in regular attendance at one or more chapter technical meetings, drinking from the fountain of youth. I know many of you passed up the opportunity because you didn't have anyone pushing you as we do with our kiddies.

No, no one will force you to attend your chapter meetings—the push has to come from inside you. You must be interested enough in getting ahead and in your future security and that of your family to break away from the easy chair in front of the TV to participate in your chapter meetings. Your chapter officers and committees have planned programs that fit the industry needs in your area, so that you can keep pace with the manufacturing technology in your field of interest. The programs presented won't do you any good, however, if you fail to attend. If you want pictures from your camera, you have to expose the film in it to the things you want to record. Your mind is like the film in a camera: it has to be exposed to your chapter technical meetings if you want to record mental pictures that you can use to reduce the costs and increase the profits of your company—which is the best way, of course, for you to increase your income and provide for your future security. It's exciting to realize, too, that in the process lies the fountain of youth. Be sure to attend your chapter technical meetings. I'll expect you there, learning and getting younger.

Dale Long

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Please DEFINE!

By Arnold W. Young
Engis Equipment Co.
Chicago, Ill.

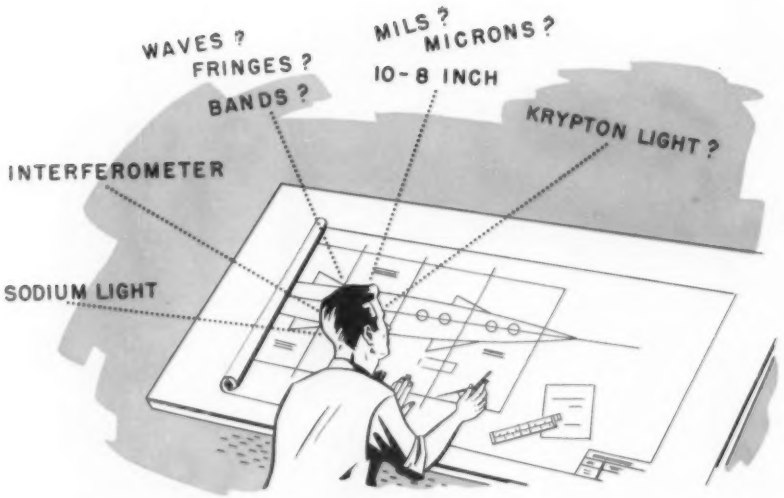
With today's tighter tolerances, better communications among product designers, manufacturing engineers and inspectors is needed. To avoid misunderstandings, the terms used in measurements must be adequately defined.

GOOD COMMUNICATIONS is the key to product quality. When product designers, tool and manufacturing engineers, the men on the production floor, and inspection personnel speak—and understand—the same language, quality stays at high levels. Without this common language, trouble results. Parts that are within specifications may be scrapped when inspectors misinterpret those specifications. Similarly, parts that are not within tolerances may pass inspection, only to be scrapped in assembly or service.

Failure to interpret specifications correctly can usually be traced to a failure to define terms. Metrology, the science of measurement, has advanced rapidly with the growing demand for measurement in millionths of inches or seconds of arc. Many of the terms used in precision measurement today have been taken from mathematics, physics, thermodynamics and other sciences. Inspectors who lack a scientific background may not understand what these terms really mean. That difficulty can be overcome by training.

But, to compound the confusion, many blueprint specifications are ambiguous. Not even an Einstein could be relied on to successfully interpret loosely written specifications. For example, blueprint specifications often state that one surface must be perpendicular to another "within 0.001 inch." This specification is confusing and it gives the machine operator and the inspector a choice of two inspection methods—methods that may lead to different results. They can measure the perpendicular as an angular value and convert to a linear value or they can measure directly to a linear value.

Normally, design or specification engineers do not intend this freedom of action, especially if the same tolerance is fitted to different lengths of a



With the advent of the Space Age, a new language has come into use in metrology. Unless terms are defined, precision is lost.

perpendicular. To specify a tolerance of 0.001 inch for a length of five inches and also for a length of 10 inches really means that two different values will be applied. Reading the specification as a linear value doubles the angular tolerance—0.001 inch for five inches equals 40 seconds, 0.001 inch for 10 inches equals 20 seconds. Machining to the 20-second tolerance can be much more costly than machining to the 40-second tolerance.

The relation of angular values to linear values is not really understood in most plants. Nevertheless, the angular method of measure is far more accurate and easier to evaluate than the linear method. Instruments such as the autocollimator, clinometer, circular table, goniometer and dividing head are becoming increasingly familiar tools. Five or 10 years ago checking the angular values of a perpendicular with feeler gages and angle plates was acceptable but today, at the advent of the Space Age, with the demand for greater accuracy, angular measurement is a necessity. And, where optical measurement is used, everyone concerned must learn a new language of measurement and learn and apply the definitions of new terms.

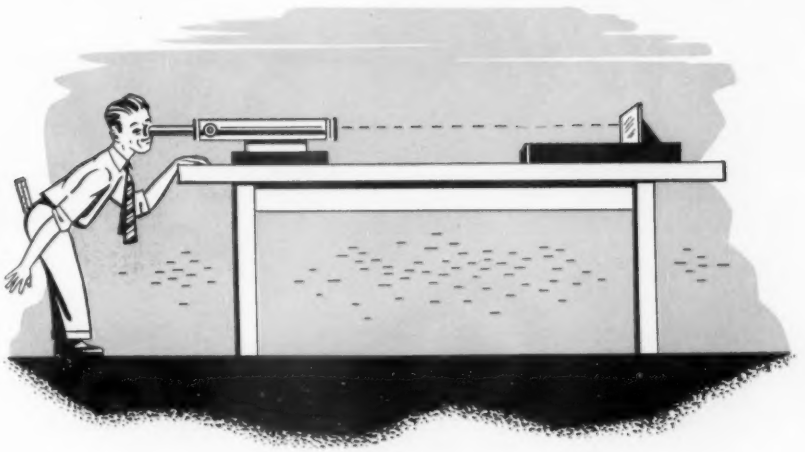
The designation of temperature values also is an area where confusion exists. Any of the three common systems—Centigrade, Kelvin or Fahrenheit—is satisfactory if the system being used is clearly identified. However, from a practical point of view, it is desirable to have the familiar Fahrenheit value follow the designated unit.

One advantage of Fahrenheit specifications is that they are easily understood by purchasing departments. Where a specification calls for a bubble level that is capable of operating in a 25 C range, most purchasing departments will buy an expensive special level. If the print calls for, say, an operating range of 50 to 85 F, they will buy a more economical standard level.

A more important advantage of specifying temperature readings in degrees Fahrenheit is apparent when working with gage blocks. In precision measurement it is essential to know how much gage block dimensions change with changes in temperature. And it is equally important to know what system—Fahrenheit, Centigrade or Kelvin—has been used in determining the degree of size change per degree of temperature change when the blocks were calibrated.

In checking the accuracy of gage blocks and flat surfaces, the most misunderstood group of terms in the field of metrology is encountered. A new group of optical instruments is required to measure flatness in millionths of an inch. The most familiar of these instruments is the interferometer. Terms such as "wave," "wave front," "band," "fringe," "Angstrom" and "micron" are often used—and misused—in interferometery. Measurement by the use of light waves, as in the interferometer, is designated by the Greek letter lambda (λ). The term micron (one micron = 40 microinches or 0.000040 inch is designated by the Greek letter mu (μ). Angstrom (250 Angstrom units = one microinch) is designated by the letter Å. Wave lengths are often designated by their wave number, which represents the number of wavelengths contained in one centimeter.

Metrologists deal with the visible spectrum, particularly in the violet, yellow and red regions. In Angstrom units, this is the 4000 to 7500 range; in microns, it is the 0.40 to 0.72 range. The dominant line of sodium has a wavelength of approximately 5890 Å to 5895 Å (yellow). The wavelength of a mercury arc is 5790 Å for yellow, 5401 Å for green, 4358 Å for blue and 4047 Å for violet. Monochromatic light has a unique wavelength, its own color and an exact sinusoidal wave form. However, monochromatic light isn't strictly monochromatic, al-



Optical measurement methods are replacing mechanical measurement for many applications. These new methods mean that inspectors have to learn new techniques and terms.

though the light produced by an isotope of mercury (mercury-198) has extremely sharp spectral lines in the yellow-green portion of the spectrum, which is the most favorable portion for visual inspection.

Metrologists can work fairly well with mercury, cadmium and sodium arcs. In fact, the most frequently used statement with regard to the specification of surface flatness includes the term: "in the wavelength of sodium." The metrologists who develop international standards have proposed that krypton light, which has an extra-fine spectral line, be made the standard. It is possible that some specifications will, in the future, read: "flat to within five bands in the wavelength of krypton."

In actual practice, however, probably only one agency in the whole country will do research work and set standards with the aid of a krypton light source. Krypton lamps, which are operated at the temperature of the triple point of nitrogen, are difficult to use. (The "triple point" is a given pressure and temperature at which the three phases of nitrogen—solid, liquid and vapor— are in equilibrium. Nitrogen melts at —345.6 F.) Under proper conditions the krypton lamp furnishes a standard line reproducible to better than 0.000004 inch. Even after the adoption of the krypton standard, the more convenient green line of mercury-198 will serve as a working wavelength standard. Mercury-198 lamps are already used in metrology laboratories.

Obviously, the type of light source must be specified when discussing interferometric measurement or misunderstandings will result.

Many questions can be raised by loose specifications on a blueprint. If a print specifies a "band of light" (such as "to be flat to 5 bands of . . .) does it refer to a fringe, a wavelength, a half wavelength? Or is the sinusoidal curve intended? The phrase a "band of light" can thus be interpreted in several different ways. Unless defined further, it is useless in precision measurement.

In standard interferometric work, the wavelengths are defined as a half-wave of 10 microinches. Actually, when using an interferometer, it is easier and more sensible to define in tenths of a whole number. A tenth of a wavelength of sodium yellow or mercury green is, to metrologists, one-tenth of half a wavelength, which is approximately equal to 0.25 micron (10 microinches or 10 millionths of an inch). The exact figure varies with the color of the light used.

Since inches or millionths of an inch are the usual units used in industry, it would be better if linear values, rather than the easily misunderstood terms "waves," "bands" or "fringes" were used. Further, even if what is meant by a "wavelength" is fully understood, the person who is using the specifications must stop and translate wavelength into values that he can use—usually millionths of an inch. There is always a possibility of arithmetical errors—errors that can be avoided by making the specification in units that can be easily read and understood by the persons using them.

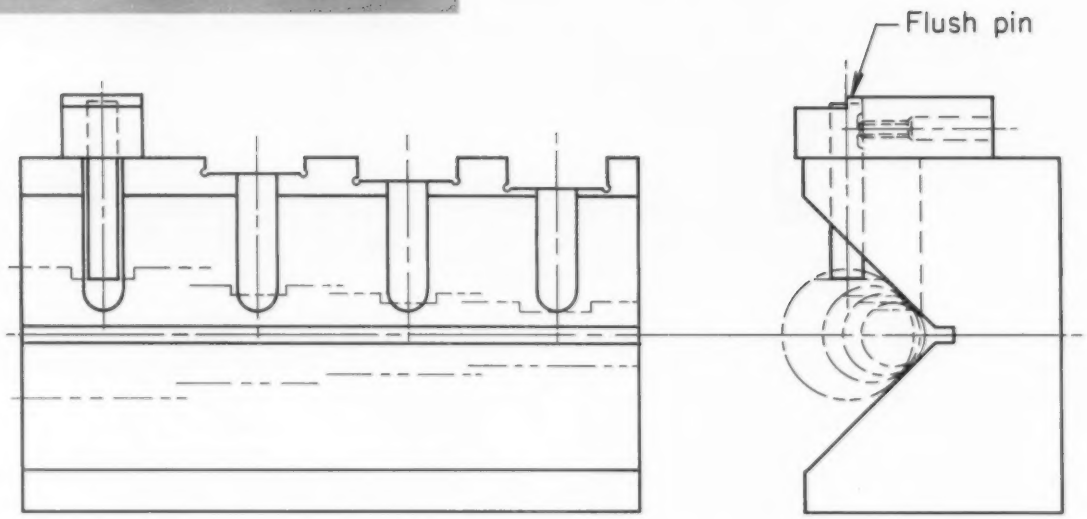
The term "millionths" is becoming common in industry. However, unless the unit is defined, there is a possibility of misunderstanding. In the metric system, one micron is equal to a millionth of a meter. If a specification reads "one part in a million" without defining the unit, there is no way for the user to tell whether microns or inches are referred to.

The term "mil" can also lead to confusion. A mil has two distinct values—an angular value and a linear value. As an angular value, it refers to roughly 1/6400 part of a circle, which is 3.4377 minutes. As a linear measurement, a mil is 0.001 inch. Both uses of the term are entirely correct as long as the units are defined.

These examples illustrate the importance of defining terms. Today there is a transition to new methods of measurement. This transition can be made easier if specifications are adequate. For better understanding—and better products—please define!

Gadgets

Ingenious Devices And Ideas

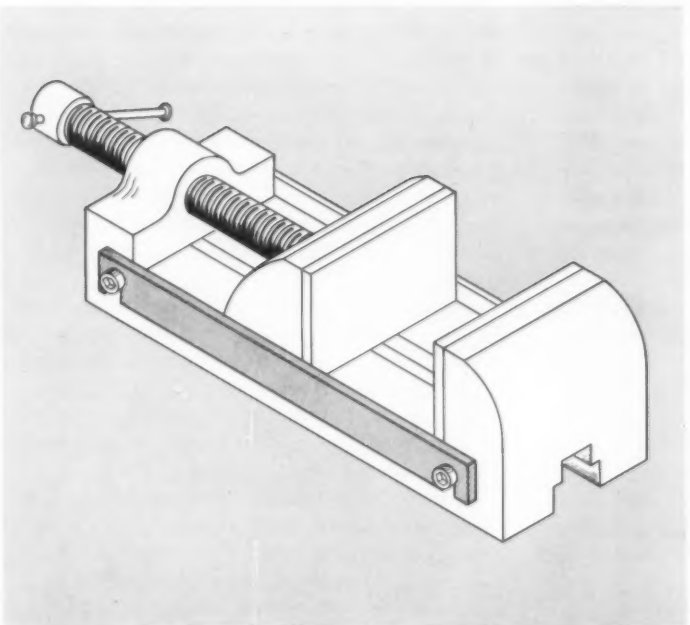


Multiple Gage Speeds Inspection

Flats of varying sizes on cylindrical parts can be inspected with the multiple flush-pin gage illustrated. Because the dimensions checked are taken from part centerlines, diameter sizes can vary within the limits of the V-block.

Additional gaging stations can be machined in the opposite side of the V-block if tool hardening is restricted to the working surfaces. Unless tolerances vary, one flush pin can be used for all gaging stations.

Robert M. Dickson
Springfield, Mass. Chapter



Vise Parallels

Drill press vises used for drilling small blocks are often abused because the toolmaker or mechanic does not take the time to set the work up with parallels. The parallels shown are attached to the vise and are always handy. The bars are made of cold-rolled steel or ground stock and are slotted to slip over two shoulder screws. The bottoms of the slots are filed to bring the parallels into correct position in relation to the drill press table. They are marked so that if removed they can be replaced in the correct position. To keep them from falling off they can be given a slight bend from end to end.

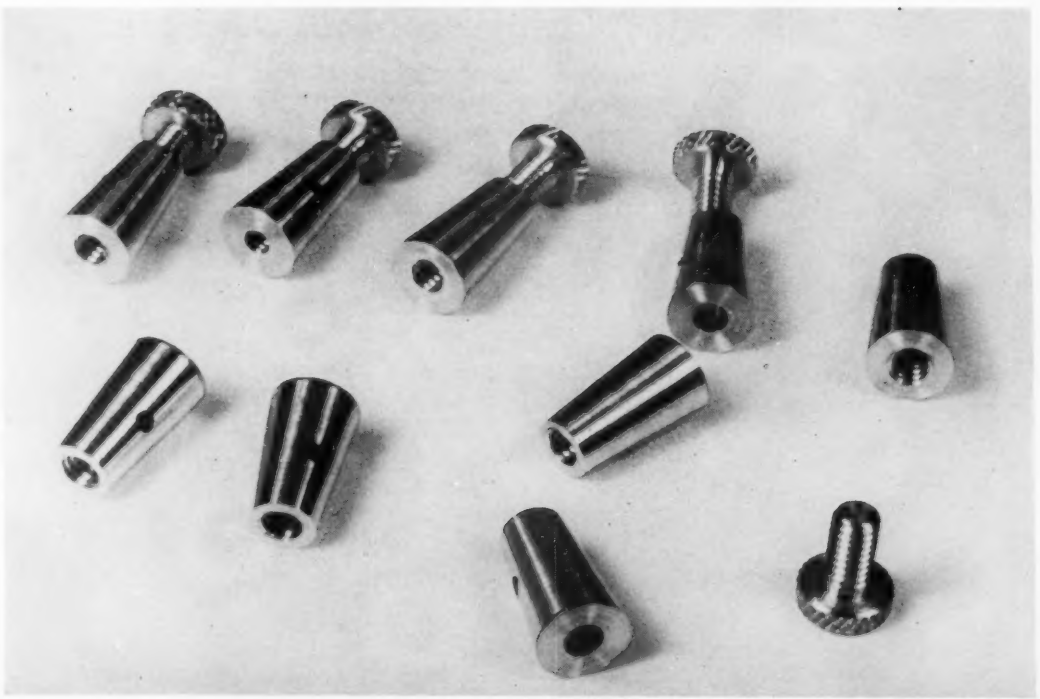
Ernest Jones, Bronx, N. Y.

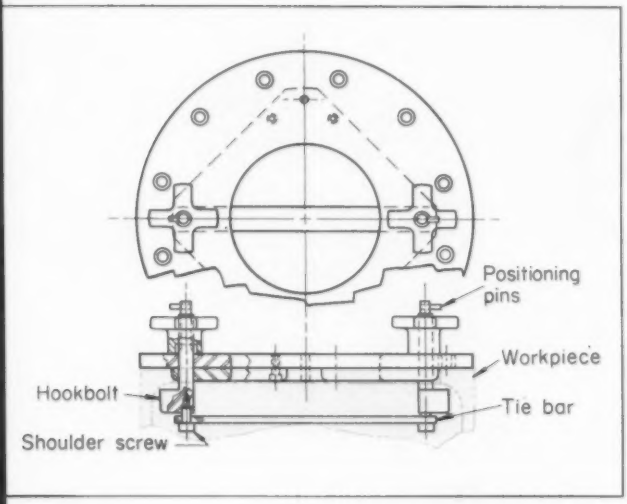
Portable Drill Eliminates Secondary Machining

This portable drill is utilized in turret lathe operations by means of the special adapter illustrated. Used to drill diametral holes at the completion of conventional machining, the drill eliminates secondary machine operations with their attendant tool costs.

Two-lip end mills can be substituted for drills when holes are machined through tapered parts. In all cases, drill and end-mill length should be kept to a minimum to avoid tool deflection.

H. J. Gerber
Member-at-Large
Stillwater, Okla.





Hookbolt Tie Bar

Hookbolts in many cases provide an easy method of clamping. An objection to them is that they will deflect when holding on a radius unless properly backed up. Providing this backup generally adds to the cost of the tool. Two hookbolts can be tied together in the manner illustrated so that deflection forces are balanced. A tie bar or link is made of cold-rolled steel and mounted on the bolts by means of two shoulder screws inserted in tapped and counterbored holes. The ends of the bolts are fitted with pins for turning them and locating position for loading and unloading. When clamping workpiece, both handknobs are turned at the same time.

F. Murray
Detroit, Mich.

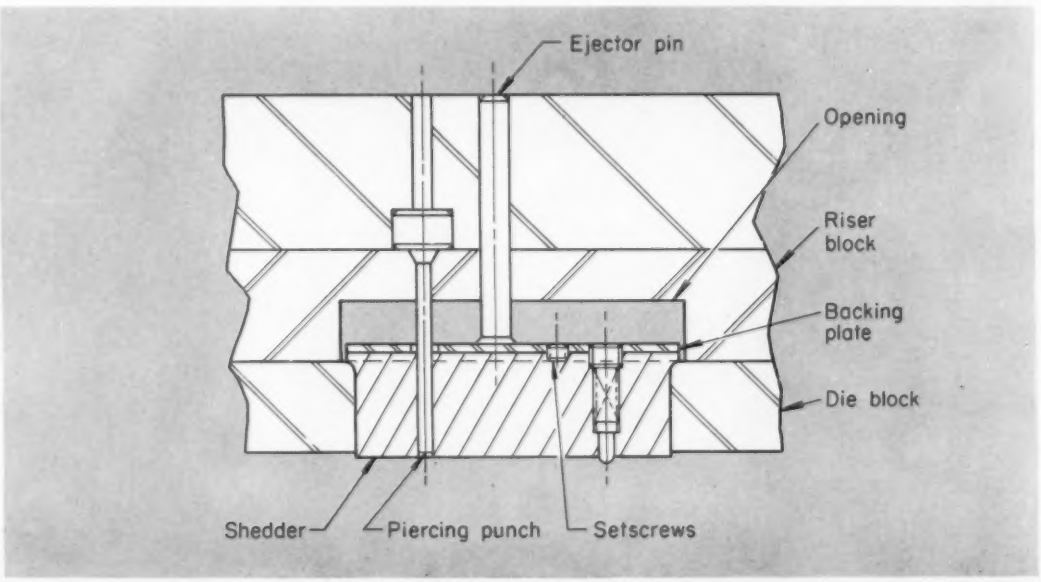
Poured Epoxy Shedder Reduces Die Costs

Shedders, the internal strippers used to eject parts from compound blanking dies, can be economically and quickly produced with poured epoxy resin. Epoxy is especially useful for this purpose when small punches must be guided and supported by the stripper.

In this technique a cold-rolled plate is sawed to within 1/32 inch of the recessed opening in the die. This plate is placed in the assembled die and plastic reinforced with steel fiber fleckings is poured into the shedder area. To assist the natural bonding action of the plastic, small headless setscrews are screwed through the backing plate before pouring.

After hardening, all excess plastic is trimmed off. The meniscus (the convex curvature at the poured surface) is then surface ground under coolant to make a smooth flat surface.

F. A. Adams
Dayton, Ohio



machining the unmachinable

...cutting tungsten with carbides

By F. J. McGee
Chance Vought Aircraft, Inc.
Dallas, Tex.

Pure tungsten, generally considered unmachinable except by grinding, can be cut by silicon carbide cutoff wheels and tungsten carbide tools. Blanking and shearing is possible in the range of 500-700 F.

OF THE COMMON METALS, commercially pure tungsten is the hardest, the most dense, the strongest and it has the highest melting point—6152 F. These properties make tungsten an attractive material for aircraft and missile fabrication. At the same time, tungsten's brittleness and abrasiveness make it one of the least attractive materials from a machining standpoint. If a sheet of 0.05-inch-thick tungsten is dropped on the shop floor, it shatters like glass. A 3-inch bar of tungsten fractures like ice if it is chucked too tightly. Tungsten is sufficiently abrasive so that small grinding wheels can be dressed with a piece of 0.05-inch sheet.

Despite these adverse properties, research work has demonstrated that it is posible to machine tungsten parts, *Fig.* 1. Several methods of machining were attempted—and sometimes abandoned—during the course of tests at Chance-Vought.

Machining Flat Stock: Sawing, for example, was not successful. A variety of blades, speeds and bandsaws was tried, High-speed steel saw blades dulled rapidly, creating a crushing action that splintered the workpiece. Cutoff wheels produced satisfactory cuts. Soft silicon carbide wheels gave best results: in some instances hard wheels would not cut. Of the feeds and speeds tried, a feed of 1-1.5 ipm and a speed of 30 fpm worked moderately well when both sides of the wheel were flooded with water-soluble coolant.

For producing flat shapes, shearing, *Fig.* 2, and blanking were tried. No success was obtained when these operations were attempted at room temperature. Acceptable cuts were made when the tungsten sheet was heated to 500-700 F. Above 700 F, the sheet became brittle, tarnished and oxidized. Other researchers are heating the metal to 3000 F and working it until the temperature drops to around 1500 F. There is apparently a zone between 700 F and 1500 F in which tungsten loses its ductility. Blanking, *Fig.* 3, was successful only when the tungsten was made ductile by heating.

Machining Bar Stock: In turning tungsten, high-speed tools failed almost instantaneously. Depths of cut in the neighborhood of 0.050 inch caused the workpiece to chip and flake. A modified BR-12 carbide grade 833 lathe tool gave satisfactory results. The side rake angle was increased to 20 degrees and the nose radius decreased from $\frac{1}{16}$ inch to a point. By roughing at a speed of 70 fpm, with a 0.005-ipr feed and 0.050-inch depth of cut, and finishing at 70 fpm, with 0.002-ipr feed and 0.020-inch depth of cut, reasonable tool life and excellent finishes were obtained. It was discovered that, because of the tendency of tungsten to crumble, all cuts except light finishing cuts should be made working toward the center of the workpiece.

Large chamfers should be used on the ends of the piece, otherwise the ends of the workpiece tend to chip severely.

As evidenced by *Fig.* 4, drilling was seven times more successful at 600 F than at room temperature, using $\frac{3}{16}$-inch high-speed steel drills in 0.050-inch tungsten sheet. However, the holes drilled at 600 F shrank undersize when the sheet returned to room temperature. Carbide-tipped drills were only slightly more successful. Despite many attempts, only two $\frac{3}{16}$-inch holes were obtained when drilling 0.020-inch tungsten sheet at room temperature. Unless the sheet was backed up, excessive chipping at drill break-through resulted. Because of the disappointing results in drilling tests, it is probably best to make holes by electrical discharge methods.

Boring was accomplished with little trouble. As in turning, it is advisable to work from the end toward the center. A standard carbide-tipped boring bar with a 45-deg lead angle, 0.010-inch nose radius and 0-deg side rake was used to open two holes from 0.375 to 0.875-inch diameter. Roughing was at 75 fpm, 0.0015-ipr feed with a 0.020-inch depth of cut. Finishing was at a speed of 75 fpm also, but with a feed of 0.0002 ipr and a 0.002-inch depth of cut.

Tapping was unsuccessful. The attempt was made with both the workpiece and the taps heated to 500 F. A set of two taps was used to limit metal removal and cutting forces. The first pass left an unsatisfactory thread, but it was hoped that the threads could be cleaned up with the second tap. The results are shown in *Fig.* 5. It is not known whether the cutting forces were too great or the lead angle lost. Even if a full thread could be tapped, the thin thread sections would be too delicate to be of real use. Partial internal and external threads were produced by thread chasing. To avoid the crumbling of tungsten at the thin end thread sections, the workpiece was supported by placing it between aluminum disks. For external threads, the disks were clamped onto each end of the tungsten piece by a bolt running through their centers. The disks were turned to the same OD as the tungsten piece. For internal threading, the workpiece was clamped between two flange-like aluminum disks and held by three bolts passing through holes 120 degrees apart on the flanges and far enough from the centerline to clear the outside diameter of the workpiece. The disks were machined to the same ID as the workpiece.

With the ends of the workpiece thus protected against the crumbling of the outermost thread sections, external threads were started in one aluminum disk, carried across the tungsten workpiece and completed in the second aluminum disk. With this setup, 75 percent threads were produced by a standard carbide threading tool having 0-deg back rake

Fig. 1. (above) This tungsten part has been turned, milled, drilled, bored, threaded and faced.

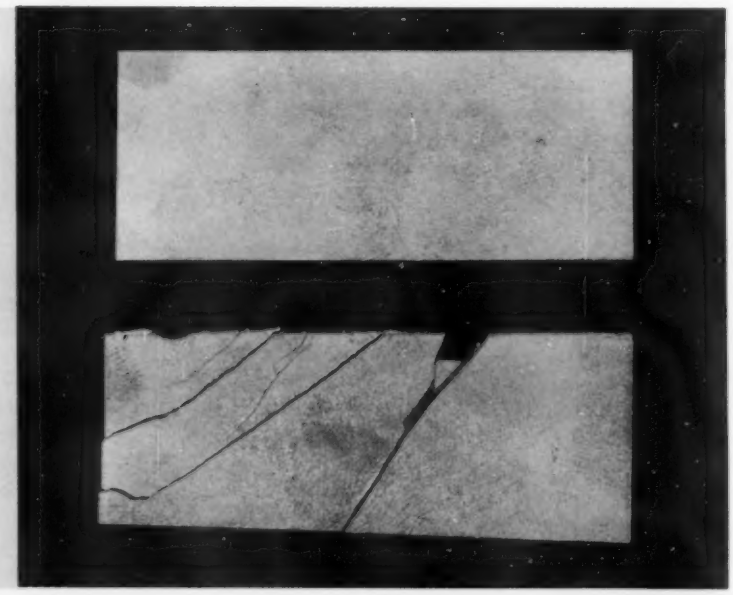


Fig. 2 (right) Sheared tungsten parts. Part at top heated to 600 F, sheared cleanly; part at bottom shattered when sheared at room temperature.

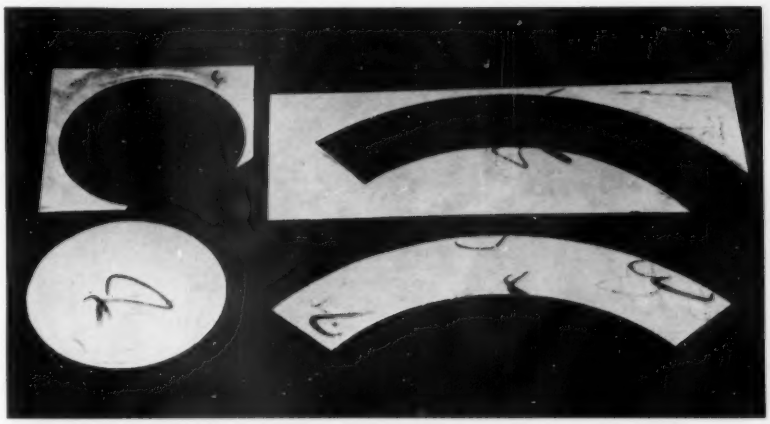


Fig. 3. Hot-blanked tungsten parts. Blanking temperature was 600 F.

and 0-deg side rake. A cutting speed of 57 fpm was used, with a 0.005-inch depth of cut for roughing and a 0.002-inch depth for finishing. Internal threads were started in one of the aluminum disks, carried through the workpiece and completed in the second disk. A standard carbide internal threading tool was used to produce 60 percent threads. Cutting speed used was of 22 fpm, with depths of cut the same as for the external threads.

Side milling produced the hexagonal sides on the workpiece shown in *Fig.* 1. Special techniques were required to prevent breakouts at plane intersections. The workpiece was encased in a thick coating of Hydrocal B, which served as a supporting medium. Several hours were required for this material to harden. As a farther precaution against breakout and crumbling, plane intersections were either either radiused or chamferred. Milling from the edges toward the center of a face might have eliminated the need for a supporting medium. However, since conventional milling tends to chip out large chunks, climb milling alone is recommended.

Several tool geometries were tried. A carbide tool, ground for aluminum, having a 15-deg axial and radial rake worked satisfactorily, although tool life was shorter than normal because the cutting edges must be sharp to reduce cutting forces. The 3-inch face mill used was operated at a speed of 70 to 75 fpm and a feed of 0.0008 to 0.002 ipt. Depth of cut was as high as 0.050 inch for roughing, but did not exceed 0.002 inch for finishing.

In end milling, breakout occurred, once near the end of the cut and once, in a different pass, at the beginning of the cut. A 0.5-inch-diam two-tooth C-6 end mill with a negative 5-deg axial rake and 0-deg radial rake was run at 90 fpm speed and a

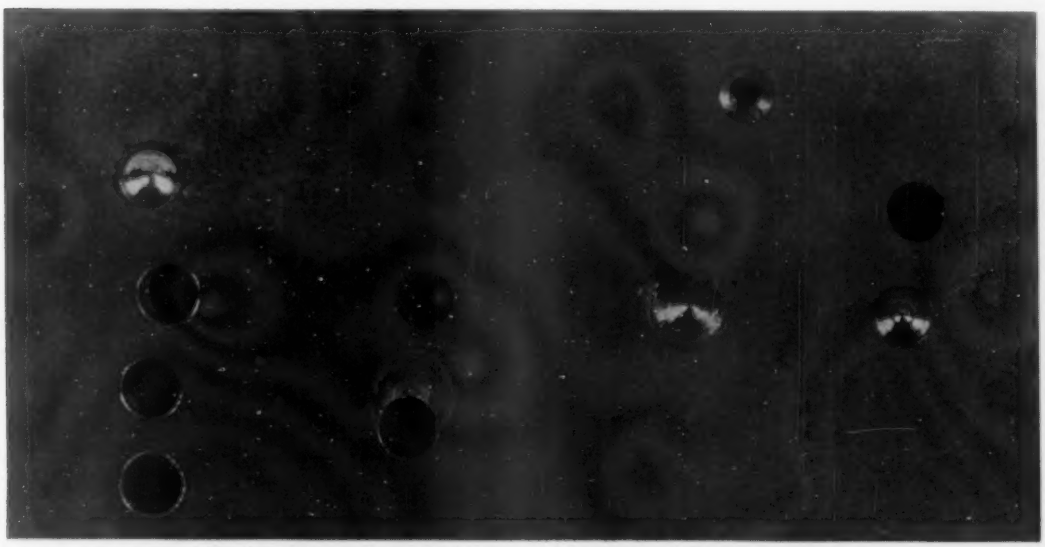


Fig. 4. Only one hole (right) was drilled successfully at room temperature. An improvement of 700 percent was gained by heating the stock to 600 F (left).

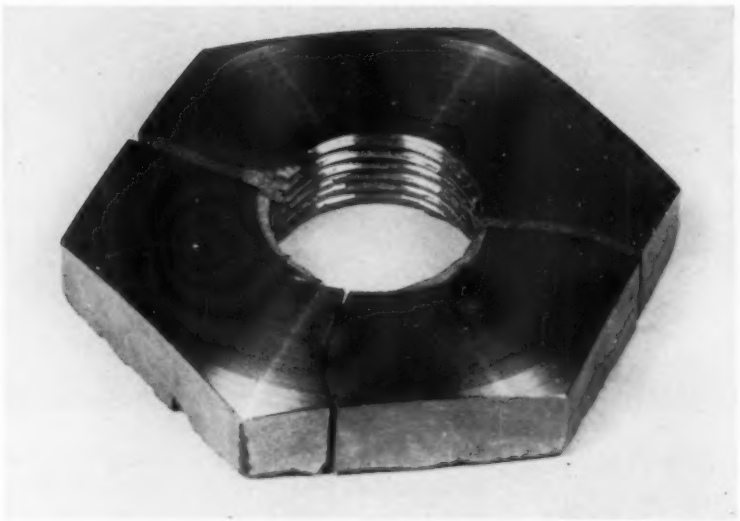


Fig. 5. Conventional tapping shatters tungsten parts.

feed of 1⅛ ipm. The depth of cut was 7/16 inch. The tool stood up but became very hot: no coolant was used. The tungsten broke out at about ¼ inch from the end of cut, suggesting that, when working near the edge, it would be preferable to reduce cutting forces or to support the edge in some way. The problem can be eliminated by working from both ends toward the middle. A shallower depth of cut (0.050 inch) was tried to reduce tool heating but the workpiece chipped along both sides of the cut during the first part of the cut. This suggests that in end milling the deeper cuts yield better finishes.

Facing was easily accomplished and gave excellent surface finishes. It was necessary to work from edge to mid-plane. A large lead angle worked well, 45 deg for roughing and 85 deg for finishing. An OD speed of 150 fpm, feed of 0.002 ipr and a 0.010-inch depth of cut were satisfactory.

To summarize: Tungsten can be successfully cut under production conditions. Tool life is tolerable, except for drilling. Carbide is the best cutting material. High-speed steel tools are virtually useless. Sharp high-positive-rake tools work best. Since tungsten exhibits little indication of plastic flow, negative rakes and dull cutting tools tend to crush the metal. By observing these recommendations, this "unmachinable" material can be tamed.

Floatless Level Controller

For controlling levels of liquid and bulk materials without the complications of floats and moving parts, an electronic device using electrode sensors has been developed by the B/W Controller Corp, Birmingham, Michigan. Primarily for use with liquids having medium to high specific resistance, (up to 12.5 megohms) the device has been tested successfully on a variety of materials—ordinary and deionized water, alcohol, glycol, anhydrous ammonia and various bulk materials having low moisture content.

An electrode immersed in the material being monitored is matched to the specific resistance of the material by selecting an appropriate value in ohms of a sensitivity resistor on the control. The electrode operates at a potential of nine volts d-c and a current of less than one milliampere. At these levels, there is no shock hazard, sparking or product contamination by electrolysis. The electrodes signal the control when a given level is passed. The control unit can be remote and accept signals from electrodes located miles away, the signals being transmitted over leased telephone lines for example. Connections at the controller can be direct, for signalling pump down or for actuating a low level alarm. By inverse connections at the controller, the signal can be used to demand a pump up action or trigger a high level alarm. Similarly, the system can be used to actuate valves or trigger other devices in packaging, batching and storage operations.

Advantages of the controller are its freedom from moving parts, sensitivity, freedom from sparking and ability to operate remote. Fail-safe operation is obtained for direct and inverse operation. Using more sensors, more levels can be controlled.

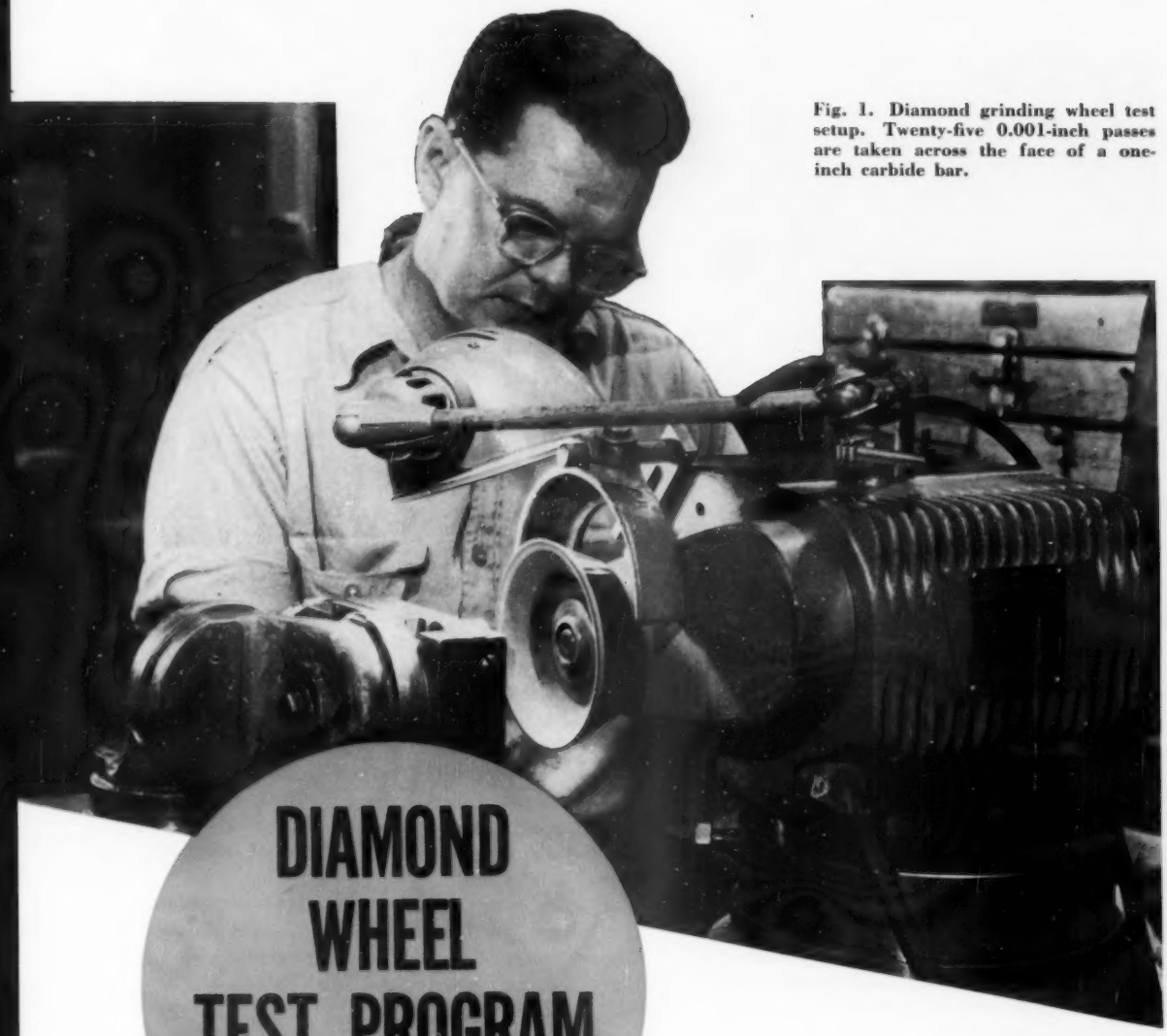


Fig. 1. Diamond grinding wheel test setup. Twenty-five 0.001-inch passes are taken across the face of a one-inch carbide bar.

DIAMOND WHEEL TEST PROGRAM PAYS OFF

Diamond wheel usage has been cut by 60 percent in tool grinding operations at Ford Motor Co.'s Indianapolis plant. New diamond-wheel control methods and a new type of natural diamond grit have contributed to this improvement.

Is THERE ROOM for cost reduction in toolroom grinding operations? Experience at the Ford Motor Co. transmission and chassis division plant at Indianapolis shows that there often is. Establishment of the full-time position of abrasives engineer at the plant, the development of a thorough wheel evaluation test, adoption of new diamond wheel control methods in the shop and specification of a natural diamond needle grit for resin-bonded wheels have all contributed to a 60-percent reduction in monthly consumption of diamond wheels.

Diamond grinding operations at the plant are extremely varied and a considerable amount of switching of wheels to different applications takes place. Principal operations are the resharpening of many types of cemented carbide tools and cutters. Cincinnati No. 2 and Oliver grinding machines are employed for virtually all dry grinding operations. Infeeds in these applications generally run from

Fig. 2. Stock removal is measured with a micrometer after taking 25 passes with the diamond wheel under test. Results guide wheel selection.

0.0005 inch to 0.001 inch. Brown & Sharpe No. 13 grinders are used in wet grinding at infeeds up to a maximum of 0.0005 inch.

Monthly diamond wheel usage in the plant is large. For that reason, putting an abrasives engineer to work on a full-time basis has been a good investment. This engineer conducts tests to determine the best wheels for specific jobs and his responsibilities cover all types of abrasive applications in the plant. In diamond-wheel applications alone, savings of several thousands of dollars per month have resulted directly from the efforts of the abrasives engineer.

Grinding wheels are tested on a scientific basis at Ford. The diamond-wheel evaluation test, for example, consists of grinding the face of a one-inch-diameter bar of Grade HD 25 die insert carbide. A 5-inch OD standard cup wheel with $\frac{1}{16}$-inch depth of 100-concentration 150-mesh diamond grit is selected for the test, since the plant uses far more of this type of wheel than any other.

These wheels are tested in two phases. In the first phase, 25 passes at 0.001-inch feed are taken across the face of the bar on a Cincinnati No. 2 grinder, *Fig.* 1. The total amount of stock removal is carefully measured with a micrometer, *Fig.* 2, and the difference between this and the total 0.025-inch feed is taken as wheel wear. In the second test phase, five passes are taken at 0.005 inch.

The 3600-rpm spindle speed of the machine gives a cutting speed of 5500 fpm. Since all feeds and traverses on the grinder are manual, the same operator is used for all tests to put them on as comparable a basis as possible.

Stock removal in the first test phase has run from approximately 0.012 inch, considered poor, to about 0.018 inch, which Ford considers good under the conditions of the test. Wheels that pass the second test are regarded as suitable for any of the carbide grinding operations in the plant.

If a wheel has performed fairly well in initial tests, six more are ordered. If a wheel performed very well in the test, 36 more are ordered. One wheel of each shipment is then subjected to the same testing as before and the others are used in normal production.

It is in production that Ford's diamond wheel control program comes to the fore. Every diamond wheel is assigned to an individual operator and arrangements are made so that no one else ever uses it. Each man is fully responsible for his wheel and must turn it in to be assigned a new one. There is no divided responsibility.

Detailed records provide an accurate history on all operations. How long a man will keep a given wheel can be predicted with fairly good accuracy —often within a day. Operator comments provide an additional, almost automatic, check on wheel performance, since any operator will quickly complain to his supervisor if he believes his assigned wheel is inferior.

On the basis of these testing and evaluation procedures, the Ford Plant now specifies needle-shaped natural diamond grit for all resinoid wheels. In this type of grit (SND-RB-Needle, supplied by the Industrial Diamond Div. of Engelhard Hanovia, Inc.) the particles are principally needle-like or plate-like in contrast to the more blocky shaped particles in conventional natural diamond grit.

The needle particles provide a better grip for the bond in resinoid wheels. Also, the needle particles tend to break off a bit at a time, rather than becoming dull and being pulled out of the wheel before they are completely consumed. This even breakdown continually exposes sharp new edges to the work. (Photographs of the various particle forms are included with the article: "Improving Grinding Wheel Efficiency," THE TOOL ENGINEER, Dec. 1959, p. 78.)

While Ford is unable to state specifically what porportion of the total savings in diamond wheel costs is attributable to each factor in their tool control program, the actual reduction in monthly usage of diamond wheels from a high of 36 wheels per month to a low of seven without any reduction in output shows that significant cost reductions can be realized through careful wheel selection and application in the plant.

Fig. 1. Preliminary contouring of the memory drum used in a computer.

Machining a Memory

...how tool engineers insure computer accuracy

Memory drums for computers are machined to tolerances of 0.000050 inch. Ingenious tooling makes it possible to hold these tolerances and, at the same time, keeps productivity at high levels.

WHILE COMPUTERS may never acquire the reasoning power of the human brain, they are capable of assimilating and processing information at superhuman rates of speed, with superhuman accuracy. Computer memory systems, for example, are capable of storing as many as 500,000 bits of information in one second.

To store information in a computer's memory, pulses are recorded on the magnetic surface of a memory drum. The final performance and reliability of the computer depend entirely on the accuracy of pulses stored in the drum and the accuracy with which the computer can interpret the bits of information represented by the recorded pulses. Maintenance of drum quality is one of the most exacting operations in the computer manufacturing industry. Extremely precise machining is required, *Fig.* 1.

A finished memory drum, *Fig.* 2, consists of four parts: the actual drum; a synchronous electric motor that rotates the drum at speeds up to 6000 rpm; an enclosing shroud in which the drum is mounted; and read-write heads. In a typical drum assembly, 40 read-write heads are mounted along the length and circumference of the enclosing shroud.

Exceedingly critical design and construction parameters govern drum assembly production. Each head must be set exactly at the same head-to-drum distance. If one misaligned head touches and scores the spinning drum, permanent damage results. If the head-to-drum separation is too great, deteriorated electronic signals result, lessening the computer's reliability. If the drum is out-of-round by any detectable value, signal modulation produces false computer answers. Thus drum-diameter tolerance in an advanced computer must fall within +0.000050 inch, −0.000000 inch.

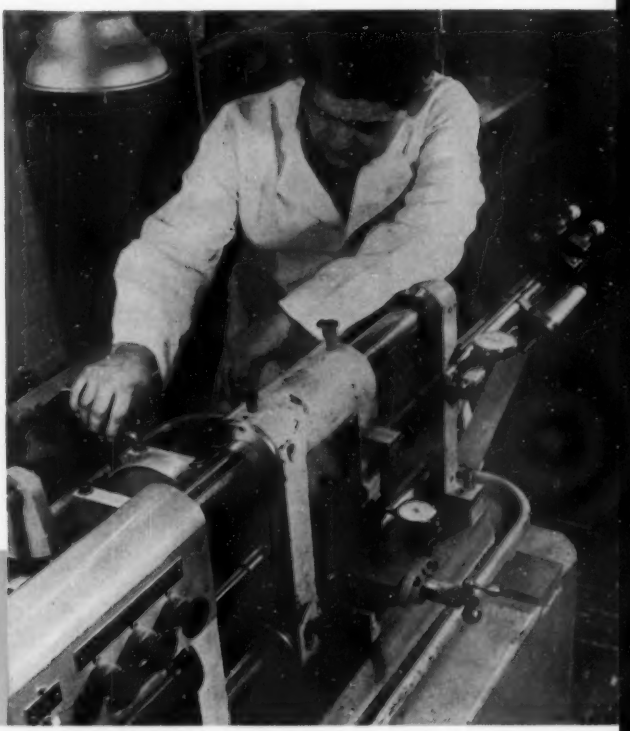


Fig. 2. Finished memory drum for airborne digital computer.

Fig. 3. (right) Precision machine used to turn the final diameter of computer memory drums. Operator is tightening fixture.

Operations at Librascope Div., General Precision, Inc., Glendale, Calif., illustrate the care that is taken in memory drum manufacture. The drums range from 4¼ to 7½ inches in diameter and up to 14 inches in length. They are machined from a special aluminum alloy. Because head-to-drum clearances must remain stable under all operating temperature conditions, the materials used in the drum assembly are selected carefully to assure proper heat-expansion properties in relation to the drum alloy. Air conditioning of the shop area keeps the machines and materials used in drum production at a fixed temperature.

The first major machining operation includes turning the diameter, relieving the undercut and forming the axle hub. This is accomplished on a precision lathe. Next, the drum is reversed in the lathe and a tracing attachment retraces the pattern to assure machining of the other side of the drum with exactly the same contour.

After boring a suitable hole, a steel shaft, chilled in dry ice, is fitted into its final position in the drum. Two matched sets of ball bearings— ground so that they have common concentricity within a total indicator reading of less than 0.000050 inch on the journal—are mounted onto the steel shaft. Eccentric spots on the two sets of ball bearings are carefully aligned along the shaft to prevent possible interaction between high spots. The drum is then mounted on a shroud subassembly.

All subsequent drum machining is done with the drum turning on its own bearings. This keeps the radial runout under 0.000060 inch, total indicator reading, and the lateral runout under 0.0005 inch.

After a surface cut on the diameter, the drum is dynamically balanced and transferred to a special machine for a finishing cut, *Fig.* 3. This machine, mounted on a 24 by 36-inch drill press table, replaces a lathe-and-saddle fixture formerly used. Complicated construction of the lathe-and-saddle fixture made change-over from one type drum to another difficult. The new machine, designed and built by Librascope personnel, can finish all sizes of drums currently in production.

A one-horsepower, 220-v enclosed motor provides a speed range of 600 to 5858 rpm and drives thin belts that rotate the drums on their bearings. A pneumatic cylinder drives the toolholder. Control of oil flow from a hydrocheck cylinder, against which the pneumatic cylinder works, regulates the speed of toolholder traverse. The pneumatic-hydraulic tool feed is extremely smooth, making it possible to obtain finishes of eight microinches or better without subsequent operations. Diamond cutting tools are used.

Fixtures on the drill press table are easily changed. To provide accurate mounting surfaces for the fixtures, the table was scraped and hand lapped. It is fastened to Meehanite anchors sunk in a one-ton block of cement, giving exceptional stability.

Fig. 4. Final fitting of end bells to the shroud assembly that encloses a finished memory drum.

When the finishing cut has been completed, the drums are coated with a 0.001-inch-thick layer of iron oxide, which is the magnetic "writing" surface. The drums are then statically and dynamically balanced to within a double-amplitude unbalance of less than 600 micro ounce-inches at 6000 rpm.

Assembly is the next step, *Fig.* 4. The finished memory drums are mounted in the shroud and the motor drive mechanism is added. Read-write heads are mounted and a skilled technician adjusts head-to-drum spacing. Following mechanical and electronic testing, the drum is added to the computer as an assembled module.

Computers have become important tools of modern industry. As the machining, assembly and testing operations at Librascope show, the success of these new tools is dependent on creative tool and manufacturing engineering.

New Prefixes Accepted

The National Bureau of Standards has decided to follow the recommendations of the International Committee on Weights and Measures to use new prefixes for denoting multiples and submultiples of units. The committee adopted the prefixes at its meeting in Paris in the fall of 1958. In addition to the eight numerical prefixes in common use, which are given in the table at right, the committee expanded the list by adding the four prefixes marked with an asterisk. Thus, for example, 10^{-12} farad is called 1 picofarad, and is abbreviated 1 pf. Expanding technology has created the need for these new prefixes.

Multiples and Submultiples	Prefixes	Symbols
$1{,}000{,}000{,}000{,}000 = 10^{12}$	tera*	T
$1{,}000{,}000{,}000 = 10^{9}$	giga*	G
$1{,}000{,}000 = 10^{6}$	mega	M
$1{,}000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$10 = 10^{1}$	deka	dk
$1 = 10^{0}$	——	—
$0.1 = 10^{-1}$	deci	d
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000{,}001 = 10^{-6}$	micro	μ
$0.000{,}000{,}001 = 10^{-9}$	nano*	n
$0.000{,}000{,}000{,}001 = 10^{-12}$	pico*	p

designed for

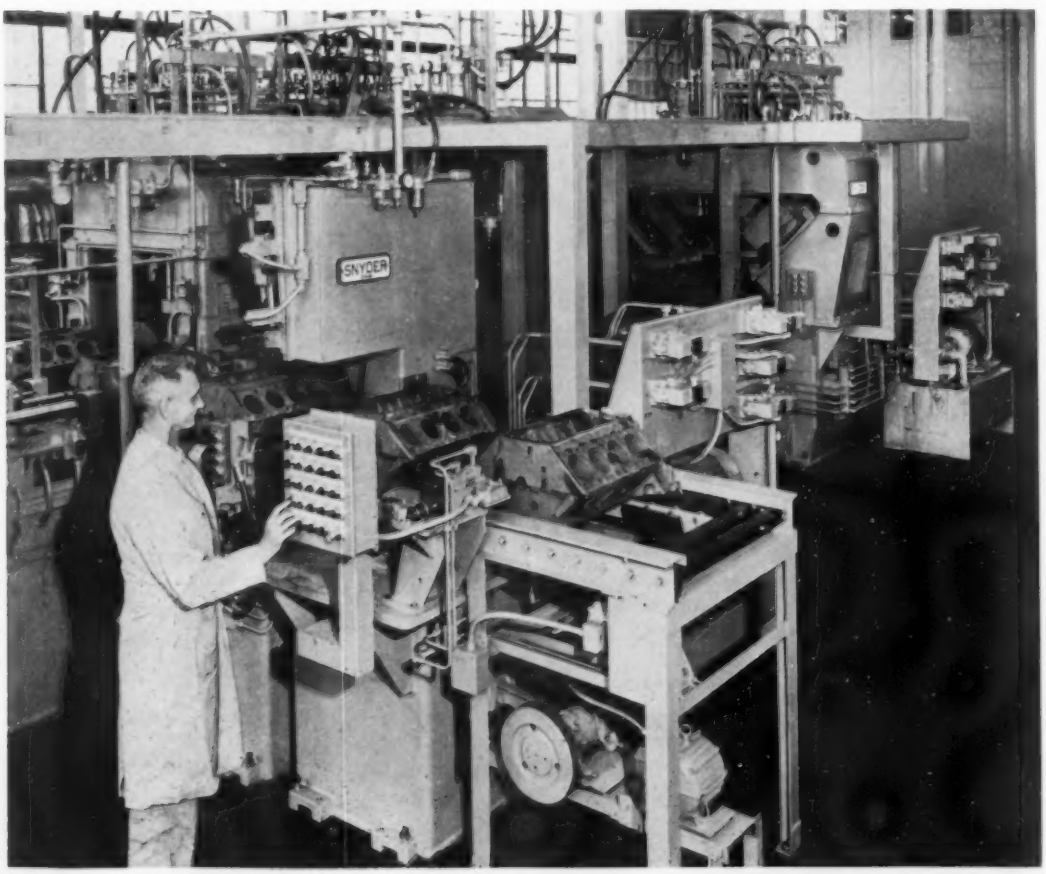
PRODUCTION

Transfer Machine Removes Casting Fins

Techniques normally applied to the machining of motor blocks are used for the removal of casting-fins in this machine. Instead of conventional cutting tools, punches and chipping hammers are used. In all other respects the machine is designed in accordance with accepted principles of part transfer, gaging and orientation.

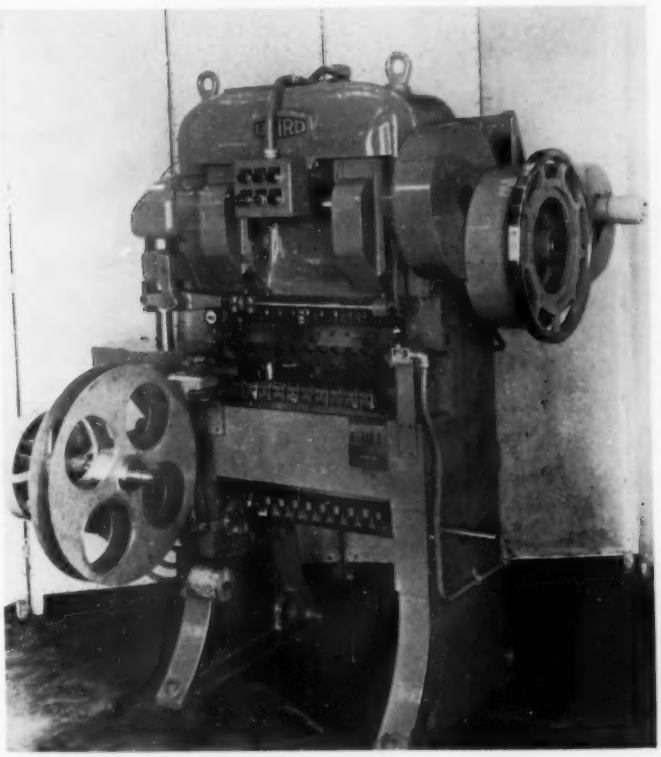
Fin removal is accomplished in punching stations by pneumatic punches which operate by weight. In chipping stations, special form tools are actuated by air hammers and operate through a preset time interval. In any station, if a fin is not completely removed, a rejection sequence is initiated by the resulting incomplete tool movement.

Designed and built by Snyder Corp., this transfer machine consists of thirteen stations in three sections. Production capacity is 240 castings per hour at 100 percent efficiency.



Transfer Press Inspects Its Stampings

Stamped parts are inspected electronically as they advance through a series of transfer dies mounted in this press. Inspection is performed by probes at each die station. When parts deviate from size, the probes—actuated by the parts—stop the press by signals to an electric clutch. The clutch, mounted below the flywheel, stops the press within half a revolution of the crankshaft. Built expressly for transfer operations, the press is a product of Baird Machine Co.

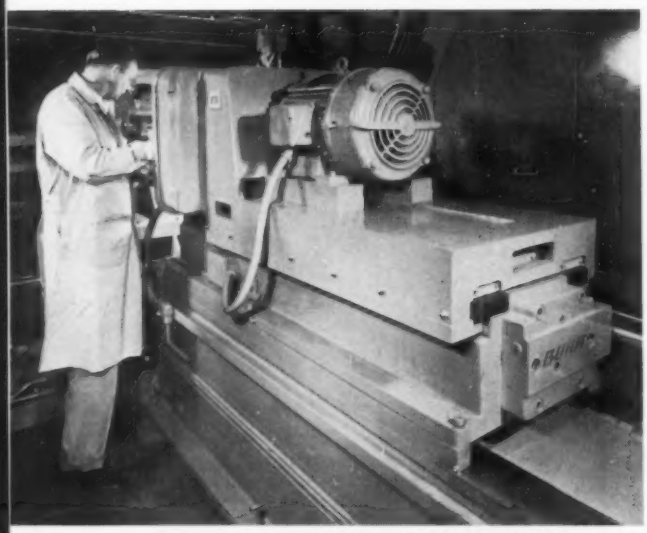


Boring Heads Cycle Independently

Boring simultaneously from opposite directions, this Pope Machinery Corp. boring machine produces holes that are round within 0.000020 inch. After a synchronized start, the two boring heads are mutually independent, each having its own cycle.

Automatic cycling of the heads is initiated by a unified control center at the right of the machine. Controls include rapid traverse, feed rate, dwell time, coolant flow and workpiece clamping.

Feed Units Simplify Machine Design

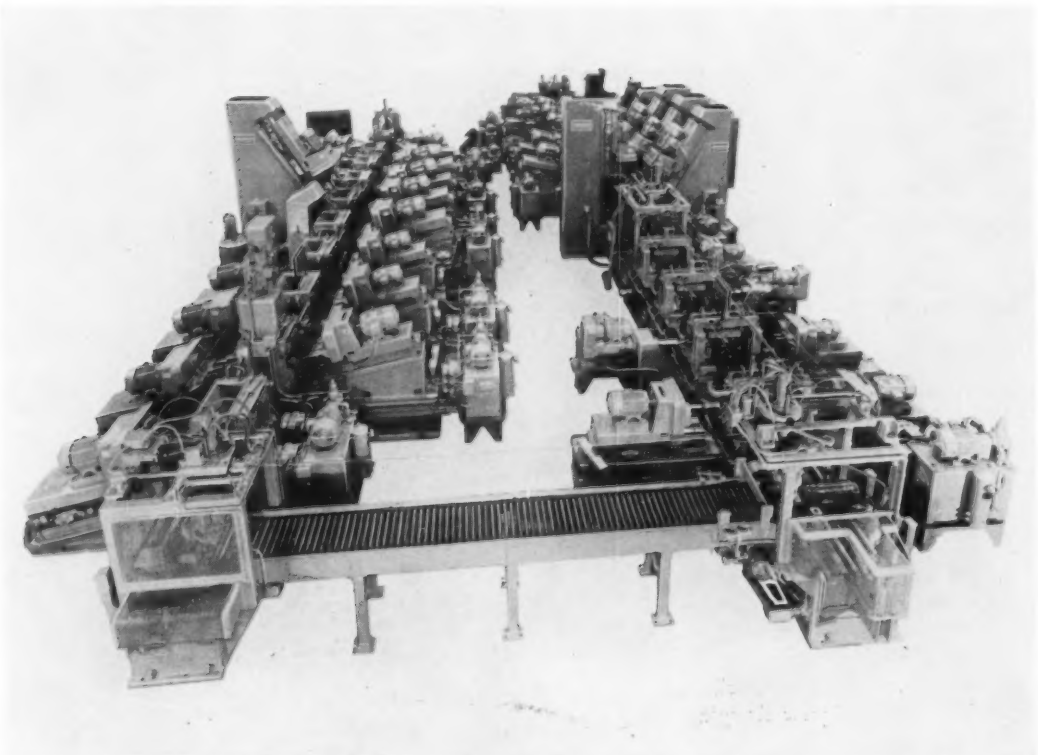


FEED UNIT in open position. Mechanism is built to new Special Machine Tool Standards.

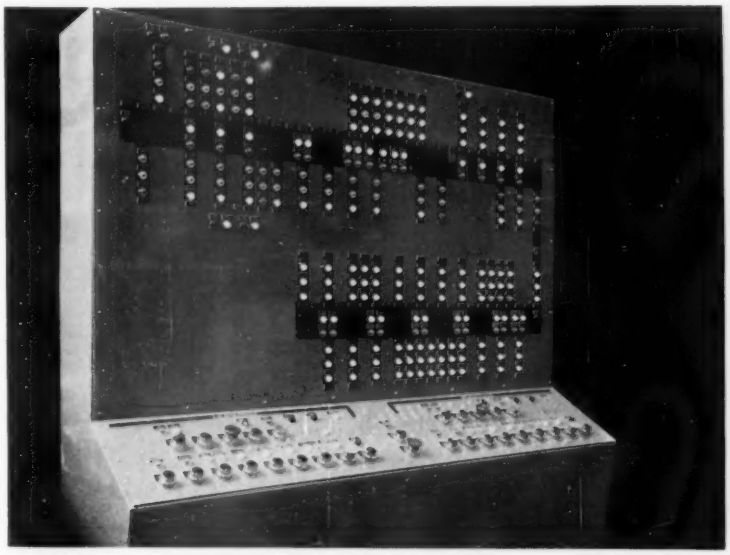
Built by Buhr Machine Tool Co., this transfer machine incorporates a versatile hydraulically operated feed unit in its design. The unit, a number of which are used, is a complete power package with all controls mounted at a master panel.

Utilizing a differential circuit, the power package reduces oil consumption by 50 percent while increasing the rate of rapid traverse by 60 percent. Because any feed unit can be removed by disconnecting three lines, problems of unit changeover are simplified.

An additional design benefit of the unit is its compact structure. This provides a relatively open area between wing bases for access to tooling.



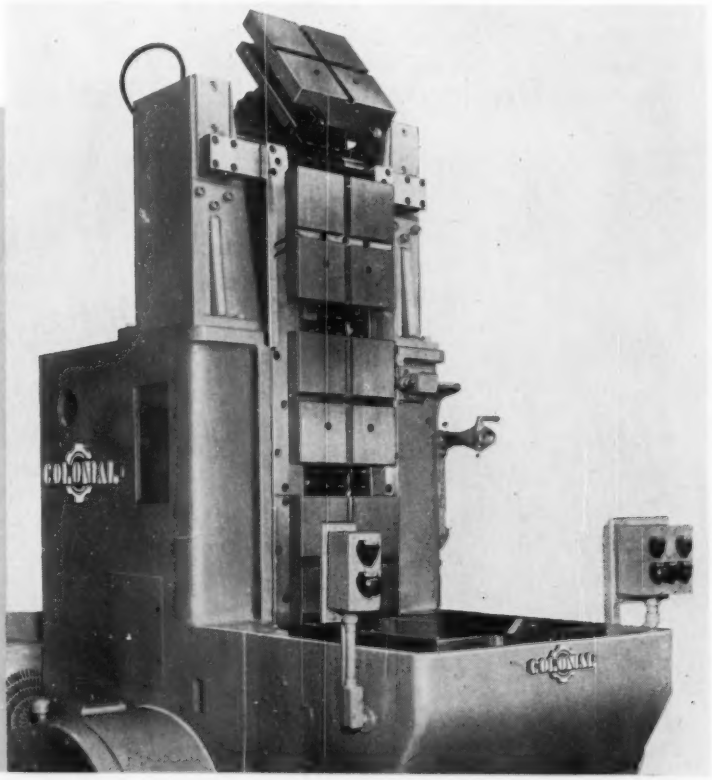
MACHINE IN OPERATION. At 100 percent efficiency productive capacity is 120 parts per hour.



CONTROL PANEL showing arrangement of indicating lights. Failure of any machine component is signaled at console.

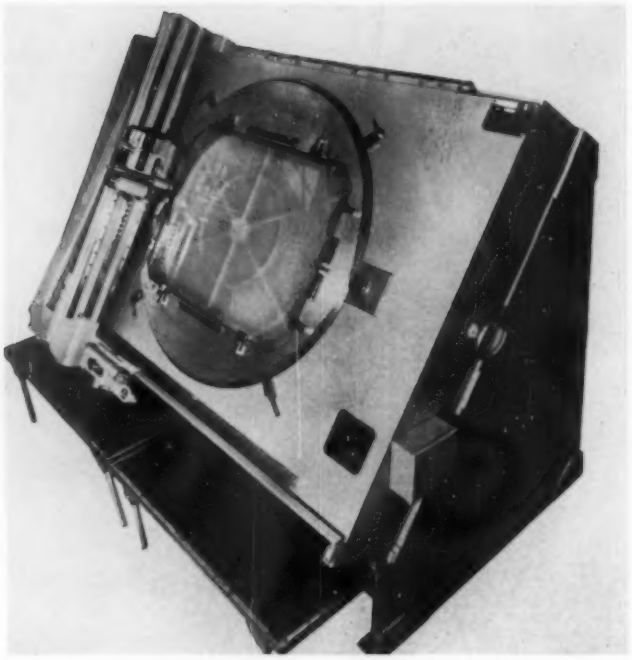
Machine Applies Ram Action To Broaching

Designed for surface broaching, this machine, a product of Colonial Broach and Machine Co., achieves almost continuous metal removal with a series of broach carriers. The carriers are mounted on an endless chain and guided through the working area by hardened ways. Utilized in this manner, they perform with the power and precision of rams.



DESIGNED FOR PRODUCTION

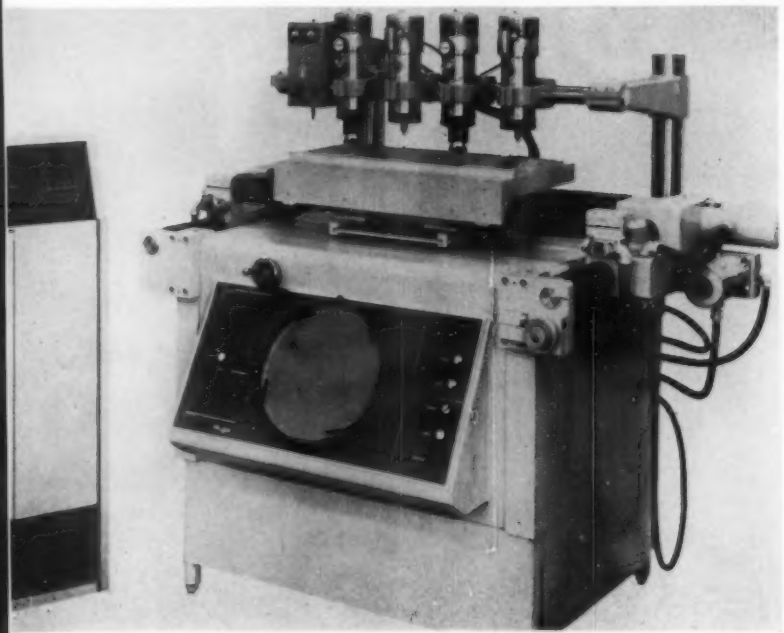
Drawings Are Scribed On Glass



Accurate drawings with tight tolerance bands are made on glass with this drawing machine, a product of Rolls Royce, England. Used as charts in optical comparators, the drawings simplify inspection of complex parts and effect reductions in drafting room workloads.

Markings on the glass—which is coated with an emulsion—are made by a scribing head equipped with a special stylus. Lateral movement of the head upon an arm which can be moved transversely enables the stylus to move in two directions. It is also possible to rotate the glass through any desired angle. The accuracy of all movements—angular or coordinate—is ensured by interval plungers and micrometer adjustment.

Drilling Machine Is Programmed Optically



Drill head positions on tape controlled machines, normally obtained from recorded X and Y coordinates, are easily and accurately established with an optical programmer in this machine. Designed and manufactured by Micro-Path, Inc., the unit uses the principle of playback to control table movements.

In programming the machine, either a master board or negative is inserted into a viewing slide located beneath the table. The view obtained, magnified by 20 diameters, is then projected on a 14-inch screen. The view of each hole is moved within a prescribed tolerance circle and a drill-down command is recorded on magnetic tape.

HOT-ROLL SPINNING
controls wall thickness

By P. C. Sun
Tainan, Taiwan
China

Hot-roll spinning makes it possible to reduce shell diameters while increasing wall thickness. Tooling and procedures for this operation are applied to a typical part.

THICKENING of sheet metal—often a necessity in the manufacture of drawn shells—is usually effected by press operations. In such cases, wall thickening may result in undesirable wrinkle formation. Also, thickness increases are generally limited to less than ten percent, and the possibility of fracture is always present.

To obtain desired thicknesses, notably in the manufacture of special containers, a hot-roll process which consists of metal spinning at elevated temperature proves useful. This technique provides an economical method of producing metal thicknesses unobtainable by pressworking.

Work pieces for hot-roll spinning of these canteens are drawn aluminum shells which have been produced by one blanking and three drawing operations. These operations, performed conventionally,

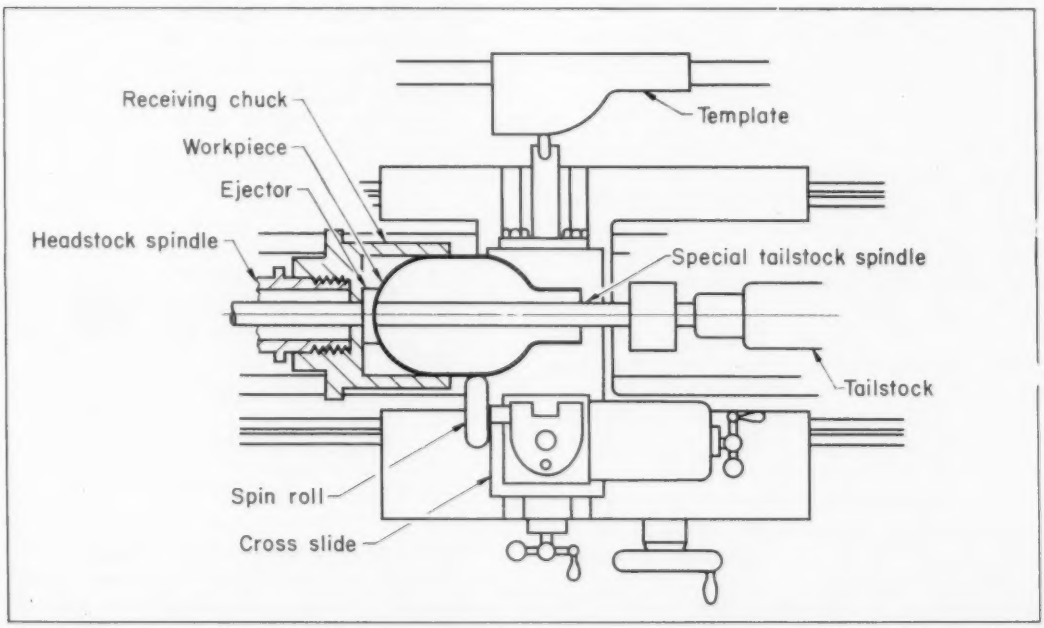


Fig. 1. Lathe setup for hot-roll spinning. Template guides the spin roll through the nine successive passes required to reduce diameter.

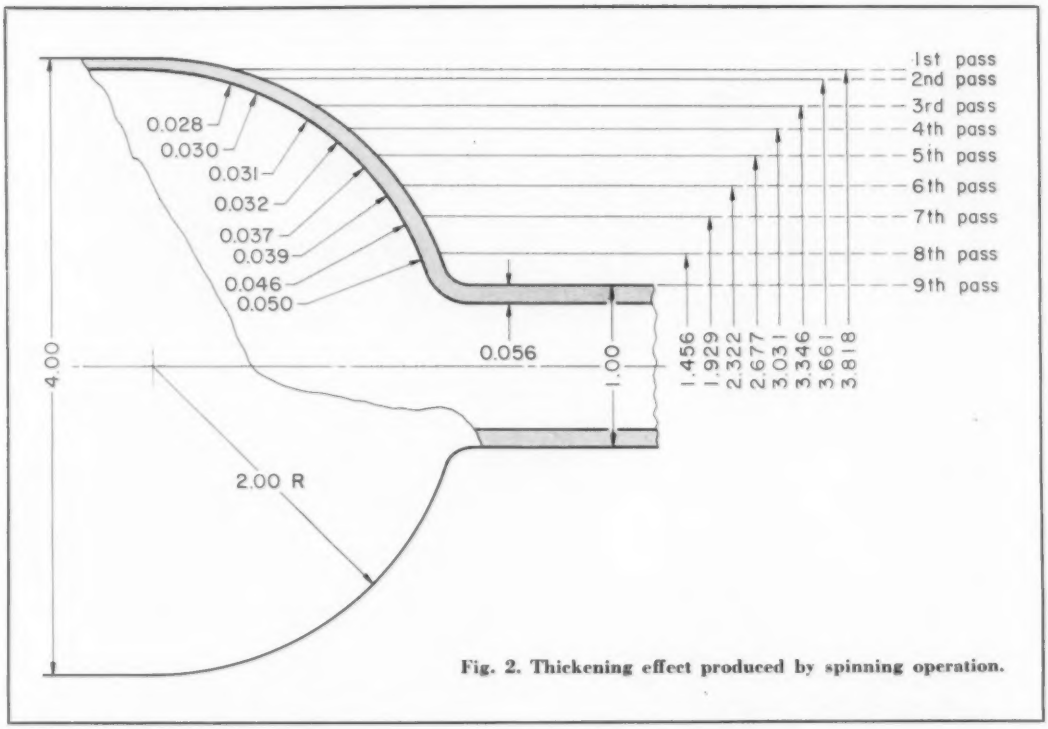


Fig. 2. Thickening effect produced by spinning operation.

present no unusual difficulties. Upon completion of the third draw, excessive flange material is trimmed and the shell is ready for hot-roll spinning.

Machine Setup: An engine lathe equipped with special attachments is used in the hot-roll spinning operation, *Fig.* 1. A receiving fixture fitted to the headstock positions the workpiece which is held in place by a rotating tailstock spindle.

A spin roll, which is the forming tool, is mounted on the toolpost and guided through the desired path by a template secured to a backrail on the lathe.

Operation: Successful hot-roll spinning requires a combination of high spindle speeds, correct temperatures and rapid transverse tool movements. Temperature is generally the most important variable. If it falls too low, wrinkle formation results. Too high a temperature causes plastic conditions which make hot-roll spinning impossible. A temperature of 750F has been found most successful when this operation is performed on aluminum shells.

Spindle speeds in a range between 300-400 rpm produce satisfactory results although speeds at the upper limit are usually more successful. Transverse carriage speeds of 36 fpm are utilized and no dwell periods are permitted. Should the rolling tool dwell or move too slowly, a thinning instead of a thickening effect results.

In operation, the spin roll—a free rotating roller—is applied to the circumference and several fast passes are made. Depth of roller penetration is then increased with each successive pass. In the illustration, *Fig.* 2, nine passes are required to reduce the part to size and produce the desired thicknesses. In this sequence, the diameter is reduced from 3.897 to 0.984 inch and wall thicknesses are doubled, *Fig.* 2.

Thickening of metal when diameters are reduced is not only desirable as a strengthening device, but necessary in this forming operation.

"You've always struck me as an average sort of fellow, Henderson, now what would the average fellow's reaction be to this design?"

BALANCING of GRINDING WHEELS

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While routine work does not require the refinement of wheel balance, vibrations due to unbalance can affect the accuracy of high-precision grinding operations. The causes and effects of grinding wheel unbalance are discussed in comprehensive fashion by the author, whose findings are based on extensive research.

ALTHOUGH GRINDING WHEELS are manufactured to closely controlled tolerances and are carefully inspected, no wheel applied to the spindle of a grinding machine will be in perfect balance. An unbalanced wheel produces forces on the spindle causing vibration between the wheel head and workpiece. This vibration, in combination with the shape of the wheel after truing, the positions of the machine slides, and the machine setup conditions, controls the geometry of the workpiece. Imperfections in the surface geometry may be detectable, depending on the inspection technique chosen. Thus, grinding wheel balance may sometimes affect the quality of the parts being ground.

The residual unbalance in precision grinding wheels is quite small. It is measured in ounce-inches. An unbalance of 8 oz-in. can be caused by a 4-oz weight on a two-inch radius, a 1 oz weight on an 8-inch radius, or any other combination of weight and radius whose product is eight. The unbalance is effective through the radial force it induces, and this force (F) depends on the product of weight and radius, and the spindle speed.

$$F = 1.775\ (10^{-6})\,\Omega^2 W r$$
$$= 1.775\ (10^{-6})\,\Omega^2 u \qquad (1)$$

Symbols in the equation are defined in the nomenclature.

Sometimes unbalance is given in ounces, in which the outside radius is implied to be the effective value of r. Thus a 16-inch OD wheel with 8 oz-in. of unbalance might be reported to have "one ounce of unbalance."

When a number of unbalanced weights are distributed around the periphery of the wheel, they may be combined by vector addition to a single effective unbalance. Two equal weights on the same radius, but spaced 180 deg apart, produce no unbalance in the wheel.*

As the wheel rotates, the induced force changes its direction periodically. The force in any particular direction, for example horizontally at the wheel head, is sinusoidal. Its frequency equals the rotational speed of the spindle, and its amplitude is given by Equation 1. The value of u for Equation 1 is the combined effective unbalance.

***This article covers precision external cylindrical grinding with wheels where the thickness is much less than the diameter. Thus only static balance is considered throughout the article.**

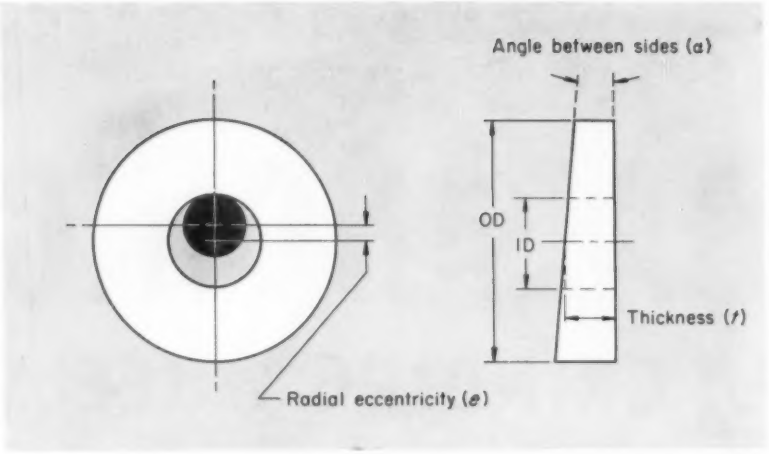


Fig. 1. Wheel and mounting geometry. Wheel hole eccentricity can cause unbalance.

Sources of Unbalance

The sources of unbalance in grinding wheels include:

1. Eccentricity of the wheel relative to the spindle
2. Nonparallel sides on the wheel
3. Nonuniform wheel structure
4. Broken-off segments of abrasive material
5. Fluid in one side of the wheel.

The first three of these are controlled by the wheel manufacturer. Balance inspection of wheels is performed while the wheels are freely mounted on a close-fitting arbor. This reveals unbalance relative to the wheel hole, including any eccentricity of the periphery with the hole, nonparallel sides and nonuniform structure. If these three sources of unbalance are well spaced (angularly) around the wheel, they tend to counteract each other. If they are all on one side, corrective weights may be required to hold balance tolerance.

When the grinding wheel is on a machine spindle, its balance is changed because there is clearance between the wheel hole and the mounting sleeve, and because the eccentricity of the periphery is removed by truing. Although the wheel unbalance produces vibrations which cause the truing diamond to remove more abrasive from the heavy side of the wheel—effecting partial correction of unbalance—this action is small enough to neglect. The eccentricity affecting unbalance after the wheel is mounted and trued is that between the wheel hole and the spindle.

Wheel sleeves and wheels are purposely made to provide clearance at the wheel hole. This allows easy wheel mounting and prevents interference stress in the wheel that might combine with the rotational stresses to break the wheel. The equation for unbalance due to wheel hole eccentricity, *Fig.* 1, is

$$u_e = 4\pi\, d_i^2\, t\, e\, \delta \qquad (2)$$

A 30 x 3 x 12-inch wheel, weighing 0.085 lb per cubic inch, with a diametral clearance of 0.006 inch on its sleeve, would have unbalance from eccentricity of 1.4 oz-in.

The sides of precision grinding wheels are trued by the wheel manufacturer. If the sides are not exactly parallel, there will be some unbalance in the

Nomenclature

F = Induced radial force, lb
R = Mean radius of workpiece, in.
W = Unbalance weight, oz
a = Amplitude of surface waviness, in.
d_i = Inside diameter of wheel (hole size), in.
d_o = Outside diameter of wheel, in.
e = Radial eccentricity of wheel hole with mounting sleeve, in.
n = Number of chatter marks around circumference, equal to Ω/ω
r = Effective radius of unbalance weight, in.
t = Thickness of wheel, in.
u = Total effective unbalance, oz-in.
u_e = Unbalance due to eccentricity, oz-in.
u_p = Unbalance due to nonparallel wheel sides, oz-in.
α = Angle between planes formed by two sides of wheel, deg
δ = Density of wheel, lb/in.^{3}
Ω = Wheel-spindle rotational speed, rpm
ω = Work rotational speed, rpm

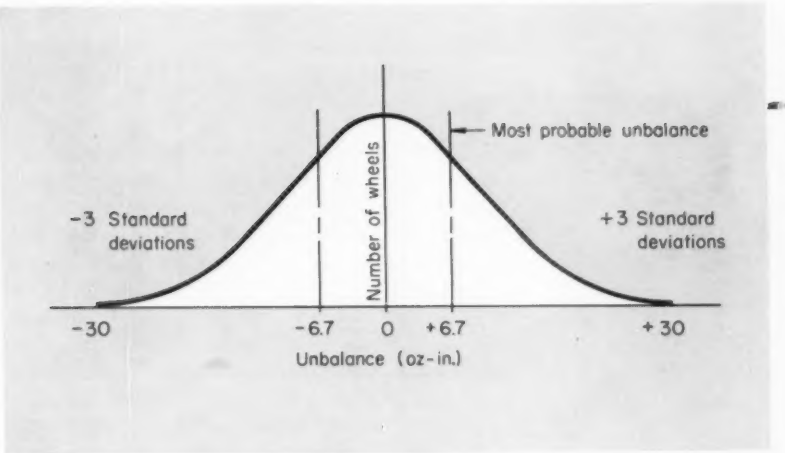


Fig. 2. Normal distribution of unbalance.

Fig. 3. (below) Time to remove unbalance due to fluid in wheel.

wheel. This unbalance may be computed from the following formula:

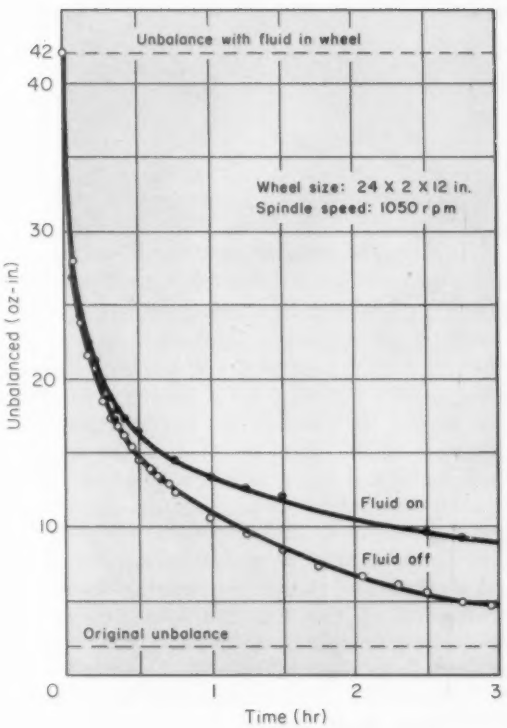
$$u_p = \frac{\pi}{4} \delta \tan \alpha \ (d_o^4 - d_i^4) \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Suppose that the 30 x 3 x 12-inch wheel described is 0.003 inch thicker at one side than at the other. The tangent of α is 0.0001 and the resulting unbalance is 5.3 oz-in. As the wheel is worn down, this source of unbalance diminishes.

The unbalance due to nonuniform wheel structure cannot be formulated. It is random and presumably follows some statistical law. It is minimized by the thorough mixing, and uniform pressing and firing techniques, of modern wheel manufacture. Heavy or light spots can be expected to be distributed at random through any volume of abrasive material. Since wheel volume increases with diameter squared, this unbalance is apt to be nearer the periphery than the hole. Therefore it will decrease as the wheel is worn down.

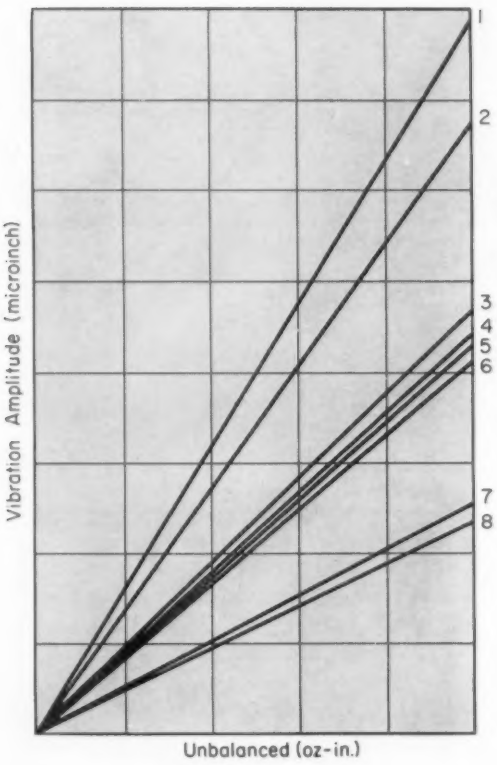
Some precision grinding wheels are marked on their light side. When this side is mounted up on a horizontal spindle machine, the air gap due to clearance between the wheel and sleeve will be on the same side as the initial unbalance in the wheel. In this case, u_e opposes u, effecting partial correction of unbalance after the wheel is trued.

To illustrate the amount of unbalance that might be expected in a precision grinding wheel, consider a hypothetical tolerance of 30 oz-in. for the 30 x 3 x 12-inch wheel. The tolerance range is ±30 oz-in., because a —30 oz-in. unbalance is a light spot on the wheel causing this amount of unbalance. A light spot acts like a heavy spot of equal magnitude, but displaced 180 deg around the circumference, and is treated as such by the inspector. All wheels of this size will be within this tolerance and the actual unbalance can be expected to follow a normal distribution curve, *Fig.* 2. Essentially all wheels fall



within ±3 standard deviations on the normal distribution curve. Since the assumed tolerance is ±30 oz-in., the standard deviation is 10 oz-in. The most probable unbalance is approximately 67 percent of the standard deviation, or 6.7 oz-in. That is, if one wheel is selected at random from a large lot, its unbalance can be anywhere in the range ±30 oz-in., but the most probable single value is 6.7 oz-in.

The unbalance of the wheel changes after mounting, because the 6.7 oz-in. (probable unbalance) includes eccentricity of the periphery relative to the



Test No.	Place Measured	Direction Measured	Wheel Slide	Correlation Coefficient
1	W	H	M	0.996
2	W	H	S	0.998
3	T	H	M	0.998
4	T	H	S	0.998
5	T	V	M	0.999
6	T	V	S	0.999
7	W	V	M	0.997
8	W	V	S	0.997

Code: W = Wheelhead V = Vertical
T = Table M = Moving
H = Horizontal S = Stationary

Fig. 4. Vibration versus unbalance for a precision cylindrical grinding machine.

hole. On the machine, the hole is eccentric on the spindle but the peripheral eccentricity is trued away. The remaining unbalance is not increased, on the average, above 6.7 oz-in. If the wheel had its light side marked for mounting up, the most probable unbalance of the wheel mounted on the spindle could be reduced by u_e, as computed earlier. This means that about 5.3 oz-in. might remain. If the peripheral wheel speed is 6500 fpm, the periodic force produced by this unbalance would have a value of 6.4 lb. Although the numerical examples are hypothetical, they show that precision grinding wheels have little inherent unbalance and that the periodic forces they produce are normally small.

Unbalance due to broken-off wheel segments depends on the amount and effective radius of the lost abrasive. If the wheel is severely damaged, it should be discarded. If the wheel is sound, it is best to dress it below the damaged area before grinding.

Fluid in one side of the wheel can cause severe and persistent unbalance. A wheel can soak up oil from the floor, or have one side wetted with grinding fluid if the spindle is stopped before the fluid supply is turned off. A test was run in which a water-soluble grinding fluid was allowed to flow for one hour on a stationary 24 x 2 x 12-inch wheel. The wheel was found to hold 3 lb of fluid; this produced an unbalance of 42 oz-in. Next the spindle was run at 1050 rpm to dry the wheel and the unbalance was noted at various times. The procedure was repeated, except that fluid was run on the wheel during the spinning period. The results in *Fig.* 3 show that the unbalance due to fluid in one side of a wheel persists for several hours and that correction is faster if the fluid is turned off.

Induced Vibration

Wheel unbalance affects surface quality through the relative vibration it induces between the wheel and the workpiece. Experiments with a large number of cylindrical grinding machines showed that wheel unbalance caused both the wheel head and work table to vibrate. With the wheel slide in motion, there was more vibration at both wheel head and table than with a stationary slide. Furthermore, horizontal vibration at both locations exceeded vertical vibration. Typical results are shown in *Fig.* 4. Numerical scales are omitted because every machine type and size has different rigidity and the figure is intended only to illustrate principles.

The results in *Fig.* 4 showed good linearity. The quality of the linearity is revealed by the correlation coefficients computed from the original data.*

*The correlation coefficient is a statistical term indicating the degree of linearity between two variables. If this coefficient equals one, the linearity is perfect. If it is zero, there is no correlation between the two.

Since the induced force (Equation 1) is directly proportional to the unbalance, it is concluded that the machine is effectively a spring of extremely high stiffness acting between the wheel and workpiece.

The phase angle between wheel head and table displacements was investigated to see if any lag developed during transmission of the periodic force from the wheel spindle to the workpiece. An oscillograph chart, *Fig.* 5, shows that no phase angle existed. This was confirmed by determining the primary critical speeds of the spindle, wheel head and table. The resonant frequencies of these components were well above the spindle speed, so no phase lag should occur. Under these conditions, the relative vibration between wheel and work will have an amplitude equal to the difference between their absolute amplitudes. The absolute amplitudes were measured in microinches and the relative vibration was less than either the wheel head or work table absolute vibration. Thus extremely small-amplitude vibrations at spindle frequency occur between the wheel and the workpiece. These are caused by wheel unbalance primarily.

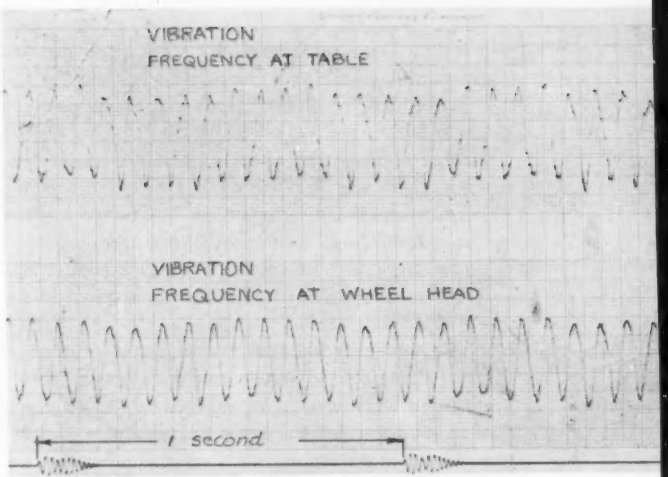


Fig. 5. Simultaneous vibration at wheel head and table. Note absence of phase shift.

Chatter

Any chatter marks on the work surface due to wheel unbalance will be synchronous with the spindle speed. For the usual precision cylindrical grinding conditions, this means a wave length on the workpiece on the order of one inch. On large-diameter work, this chatter would appear as waviness on the surface. For small diameters, chatter with this wave length would be detected as out-of-roundness.

The amplitude of the induced waviness, or the amount of out-of-roundness, depends only in part on the relative vibration between the wheel and work. If the wheel is trued from the table, an eccentric shape that compensates for the vibration is imparted to the wheel. Thus, the wheel face "acts round" relative to the workpiece. The relative vibration between the truing diamond and the wheel may never exactly equal the relative wheel-work vibration, but the surface waviness will be substantially smaller than the amplitude of relative vibration.

Fig. 6*a* shows exaggerated chatter patterns from large vibrations. The curvature of the wheel limits the height of the peaks in this case. A small vibration produces a pattern characterized by *Fig.* 6*b*. Here the surface is a series of convex arcs. Precise balance or perfectly compensating truing will result in a circle, *Fig.* 6*c*. Wheel unbalance can be expected to give chatter like that shown in *Fig.* 6*b* but with much less prominent peaks.

In *Fig.* 6, a whole number of waves appear around the circumference. Unless the ratio of wheel-spindle speed to work-spindle speed (Ω/ω) is a whole number, the chatter induced during any workpiece revolution will be out of phase with the vibration on subsequent revolutions. This tends to erase and break up the pattern.

Chatter Detection

The most common inspection technique for chatter on cylindrical surfaces involves wrapping a fine wire around the surface and drawing it back and forth under light tension. This method is illustrated in *Fig.* 7. If the wire becomes a chord of a circle drawn through the wave peaks, as shown, the minimum number of waves to allow detection is:

$$n = \frac{\pi}{2}\left(\frac{R}{a}\right)^{1/n} \qquad \text{.....(4)}$$

This condition requires infinite tension in the wire, so a lesser number of waves is actually detectable by wire rubbing. However, the wave amplitude due to unbalance is a matter of microinches and the work radius is measured in inches, while the ratio of wheel to work rotational speeds (Ω/ω gives the number of waves around the work circumference) is on the order of 10. Thus, chatter from wheel unbalance is generally too widely spaced to be detectable by this method.

When Equation 4 applies, the distance d in *Fig.* 7 becomes zero. If there were fewer than n waves, the work would appear convex between peaks, as in *Fig.* 6*b*, and the wire would touch all points around the circumference.

Some of the principles described here were confirmed by experimentation. Weights were used to cause a 27 and a 62-oz-in. unbalance in an otherwise precisely balanced wheel. First, the wheel was trued while in balance, then used in balance and with the two steps of unbalance. In a second test series, the

wheel was trued while 27 oz.in. out-of-balance, then grinding was performed for the balanced and unbalanced conditions. The final series used a wheel trued while 62 oz-in. out-of-balance. The work speed was 100 fpm and wire-rubbing revealed no chatter for any combination of truing and grinding conditions. This was because the wave length was too great, as predicted by equation 4. The work speed was reduced to 12 fpm and the tests were repeated. Under the light wire tension employed, chatter was now detectable. The results are summarized in the accompanying table.

Tests Revealing Chatter Marks

Unbalance While Truing (oz-in)	Unbalance While Grinding (oz-in.) — 100 fpm		— 12 fpm —	
	0, 27, 62	0	27	62
0	No	No	Yes	Yes
27	No	Yes	No	Yes
62	No	Yes	Yes	No

The table reveals that truing could produce a wheel shape able to compensate for even the severe vibration from 62 oz-in. of unbalance. (This amount of unbalance is several times the maximum allowed at wheel inspection.) Furthermore, balancing the wheel after truing destroys the advantage gained from the eccentric wheel face left by the diamond. Truing should be the last operation on the wheel.

Need for Balancing

In the past, wheel unbalance has been a common cause of surface waviness. Because of this, wheel manufacturers have tightened balancing tolerances and builders of grinding machines have improved the rigidity of their products. As a result, wheel unbalance is a minor problem today and can be ignored in the majority of practical precision grinding jobs. This is proved by the large number of installations where the balancing weights are removed from the mounting sleeve and wheel changes are made with the sleeve in place on the spindle.

The inherent unbalance of precision grinding wheels is usually only a few ounce-inches. When the wheel is properly mounted on the spindle, with its light side up, the unbalance is partially corrected. The force induced by the remaining unbalance is typically a few pounds. On a modern precision grinding machine, this force causes a vibration of the the wheel head measurable in microinches. However, this force is also transmitted through the base to the table. Thus, the relative wheel-work vibration is smaller than the wheel head vibration.

When the wheel is trued, there will be relative vibration between the diamond and the wheel spindle. This produces an eccentric wheel periphery which helps the wheel face to "act round" relative to the work. Therefore, the amplitude of waviness on the work surface will be less than the relative wheel-work vibrational amplitude. Furthermore, since the ratio of wheel to work rotational speeds is seldom a whole number, the chatter pattern is broken up and reduced in height during spark-out.

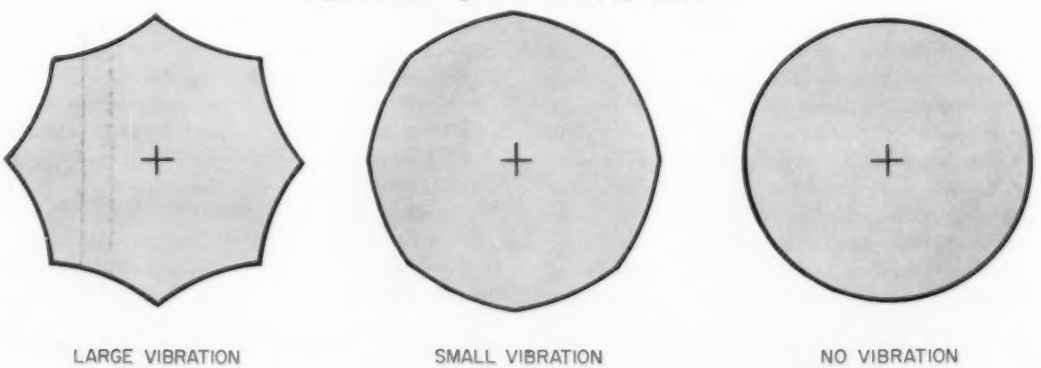
Waviness of a few microinches height and broad wave length is difficult to detect on a cylindrical surface. Normal grinding conditions will not produce unbalance-induced waves that are readily discovered, and they apparently are of no consequence to the utility of the part ground. Generally, a surface must have a very fine finish (less than 10 microinches, AA) to allow detection of chatter caused by unbalanced wheels.

Fluid in one side of the wheel can cause severe unbalance that will leave chatter marks on the work. The operator should avoid this condition.

The conditions where wheel unbalance might cause chatter would be when a very fine finish is being produced and one of these conditions apply:

1. The workpiece is large; or there is a relatively large ratio of work to wheel size; or the work speed is unusually low
2. The ratio of wheel to work rotation speeds happens to equal a whole number
3. The machine is not of rigid construction, or has not been well maintained
4. The wheel is chipped or has fluid in one side.

Fig. 6. Chatter patterns caused by vibration.



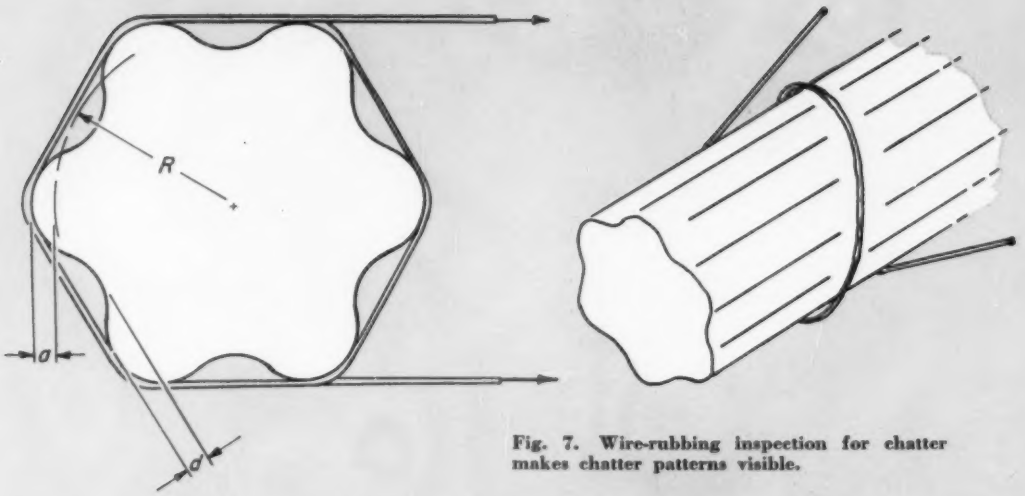


Fig. 7. Wire-rubbing inspection for chatter makes chatter patterns visible.

Proper attention to machine settings and maintenance will often help correct chatter. Wheel-mounting sleeves are equipped with balancing weights capable of removing excessive unbalance when correction is essential.

The effect of wheel unbalance on wheel performance has not been discussed here. There is evidence that high-frequency vibration between wheel and work can accelerate wheel wear. However, no effect of small spindle-frequency vibration on wheel life is known. Furthermore, wheel costs are normally a negligible part of over-all grinding costs, so any such effect would have minor economic consequences.

It should be remembered that wheel unbalance only causes wide-spaced waviness synchronous with spindle speed. Wheel balancing will not correct the rough finish or fine chatter marks caused by improper wheel action or higher-frequency sources of vibration in the machine.

Practical Conclusions

The practical conclusions from this discussion are as follows:

1. Precision grinding wheels used on rigid machines do not normally require refinement of their inherently good balance
2. Following the wheel manufacturer's mounting instructions will reduce initial unbalance
3. Proper truing and machine settings can help compensate for unbalance-induced vibrations
4. Very shallow, widely spaced waviness may arise from unbalance, but may not be readily detectable. It will generally have no effect on the function of the ground part
5. Grinding wheels should be stored on racks off the floor to avoid oil absorption on one side
6. Grinding fluid should be turned off before stopping the wheel spindle
7. The machine should be maintained to preserve its original rigidity
8. Wheel balancing is no cure-all for poor grinding finishes
9. When balancing is required, the machine manufacturer's instructions for adjusting the weights provided in the wheel sleeve should be followed
10. A wheel should always be trued after it is balanced. A new wheel should also be trued on its sleeve before it is balanced.

When these recommendations are followed, grinding wheel unbalance should not be a problem.

"The boss says to relax, take a break and stay overtime tonight until the job's done—"

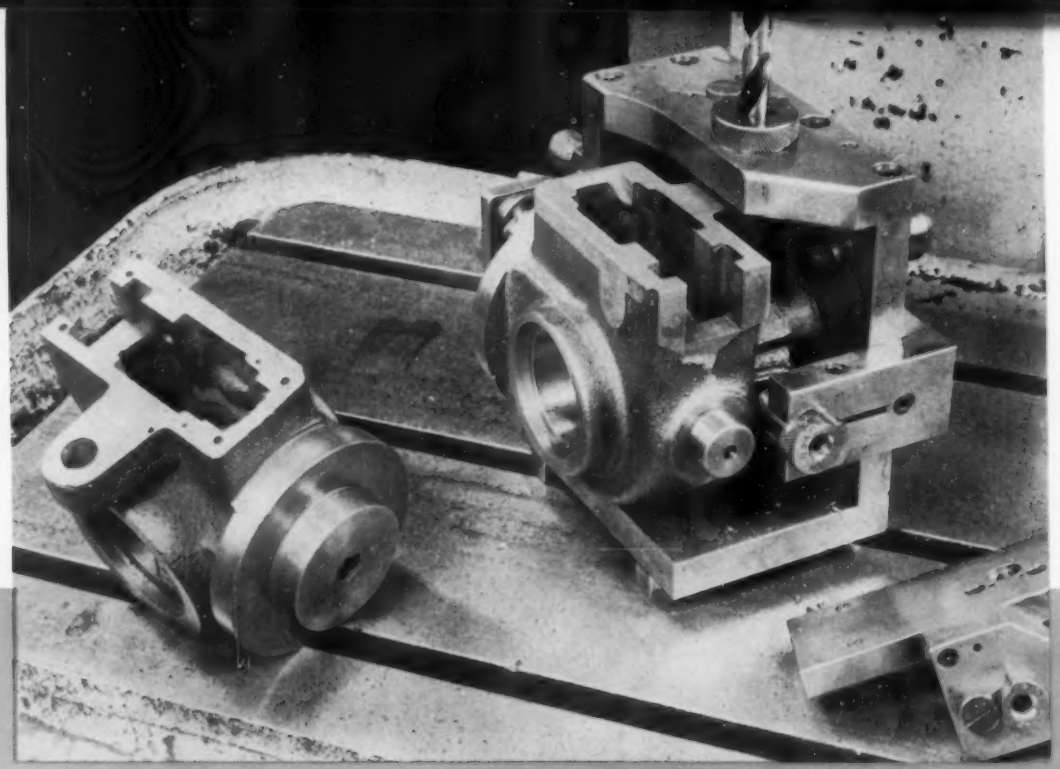


Fig. 1. Master jig holds workpiece and is used for drilling two holes. Auxiliary jigs are added for drilling other holes in casting.

Auxiliary Jigs Cut Tooling Costs

Providing a master jig to hold the work and a series of small auxiliary jigs to locate groups of holes is a low-cost way to insure that hole location tolerances are met. The author shows how this principle has been applied for machining a complex casting.

PREVENTION of cumulative errors in hole positions is one of the most important problems when designing tooling for complex workpieces. It may not always be practical to dimension and tolerance all hole locations from a common location or reference surface. Often certain holes are closely related to individual features of the workpiece, such as a milled slot, a certain opening or a surface other than the one from which the workpiece is located in the jig.

One common way to provide for the proper positioning of these unrelated groups of holes is to use a number of jigs, each jig locating the workpiece on the feature that is important to the holes that will be machined with that jig.

The same result can be obtained at far less cost by using a master jig to hold the work and a series of small auxiliary jigs to locate various groups of holes, *Fig.* 1. These small jigs are designed to locate themselves on workpiece features that are related to each group of holes. Consequently, the resulting holes are entirely independent of the prime locating surface on which the workpiece is seated in the master jig. Accuracy is assured.

*ASTME member-at-large.

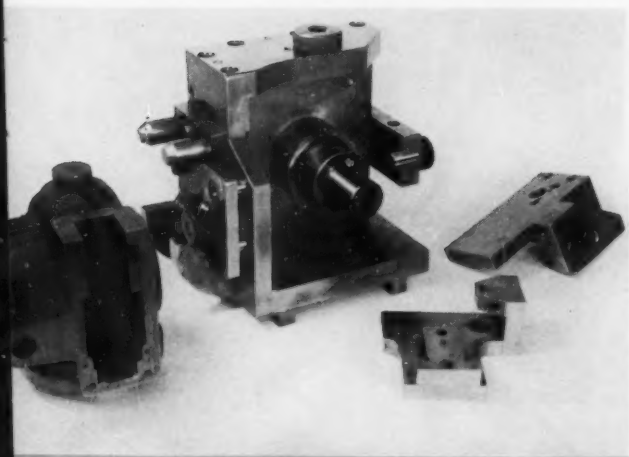


Fig. 2. (above) Master jig and two of the four auxiliary jigs.

Fig. 3. (right) Spring-loaded equalizer holds casting in master jig.

Fig. 4. (lower right) First auxiliary jig in position for machining.

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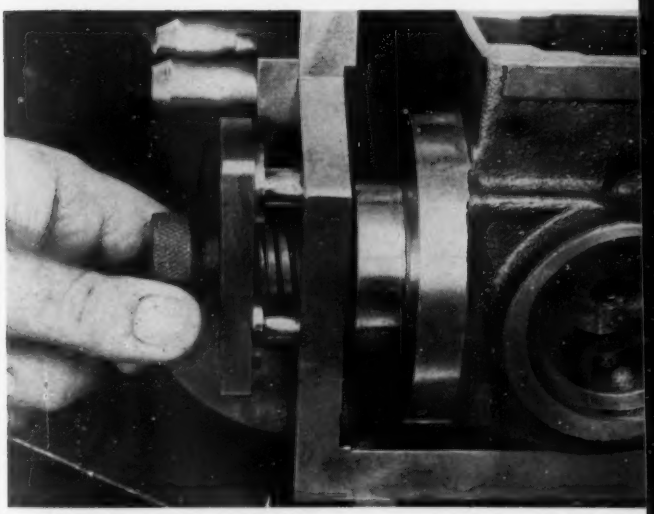
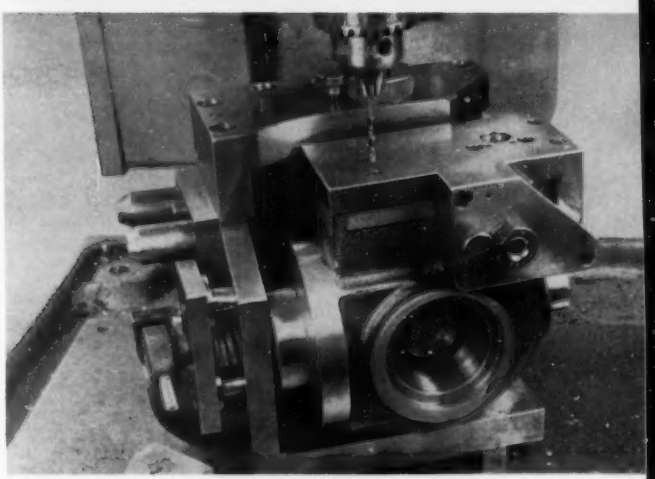
The workpiece illustrated is the main housing casting for a small dividing head. Holes in one side of this casting may have no precision relationship to holes on the other side of the casting, but they must be accurately located with respect to some adjacent feature on the casting. The milled opening in the top of the casting, for example, does not have to be accurately positioned with respect to either of the two location surfaces in the master jig. A series of holes adjacent to this slot, however, is toleranced closely to the side and end surfaces of the slot. Thus the auxiliary jig used in machining these holes is located directly on these surfaces.

The master jig and two of the four auxiliary jigs used to machine all the holes in the casting are shown in *Fig.* 2. The casting is located on the master jig by means of a central stud locator, which seats into the finished bearing bores of the casting, and a spring-loaded equalizer seated against the faced surface of the tilt trunnion on the casting, *Fig.* 3. Two holes are drilled and reamed through bushings in this jig and both are related to the prime location surfaces.

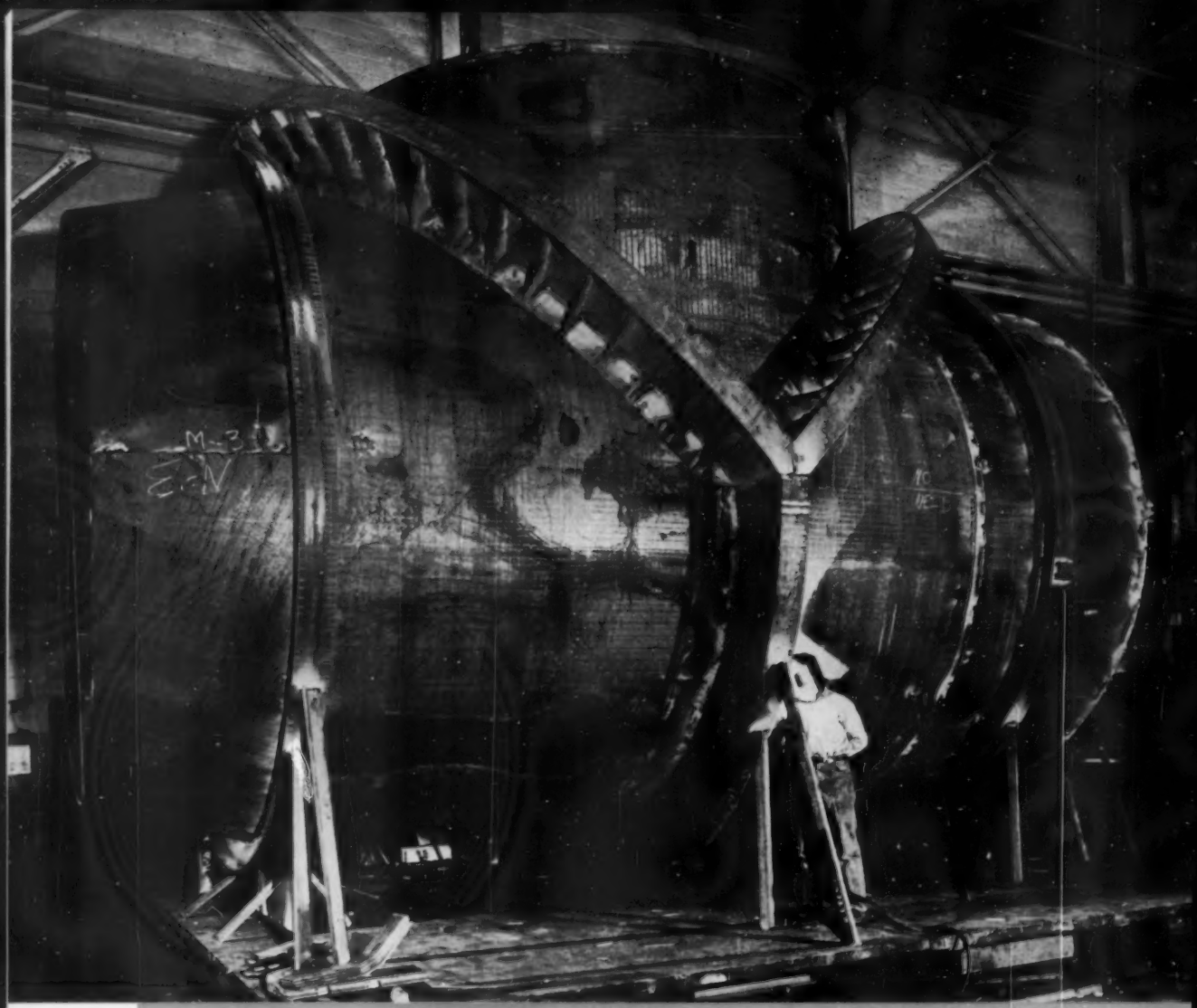
One of the auxiliary jigs is then seated in the milled slot in the top of the casting and is used for drilling several small holes in the top surface, *Fig.* 4. The master jig is then rolled over for machining





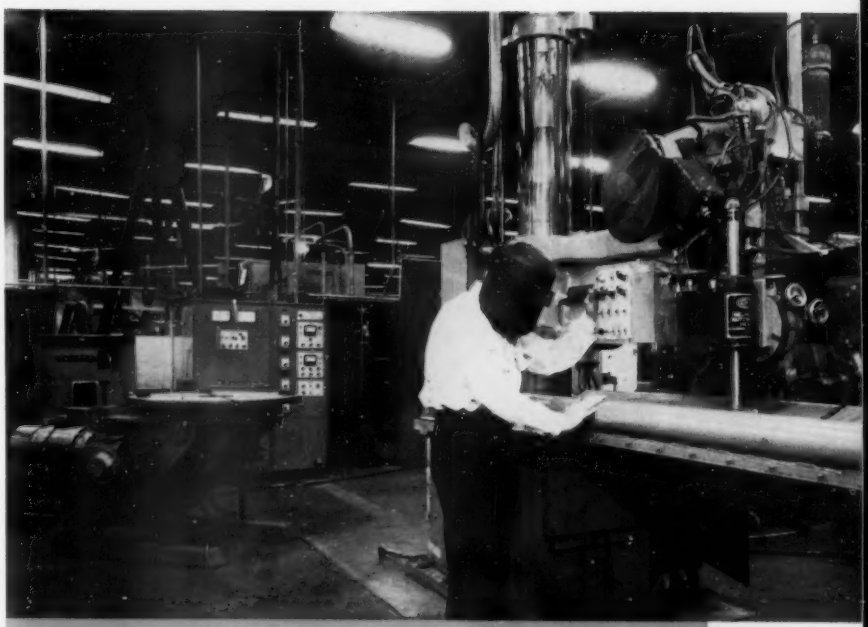
the hole at the bushing location on the side surface of the auxiliary jig. This jig is then replaced with another jig for drilling of oil holes to the two main bearings of the casting. The two additional jigs, not illustrated, are similar to the first auxiliary jig.

The low cost of the auxiliary jigs is only one of several advantages. Much time is saved as well, since removing and replacing the casting in a series of conventional jigs is a slow process.



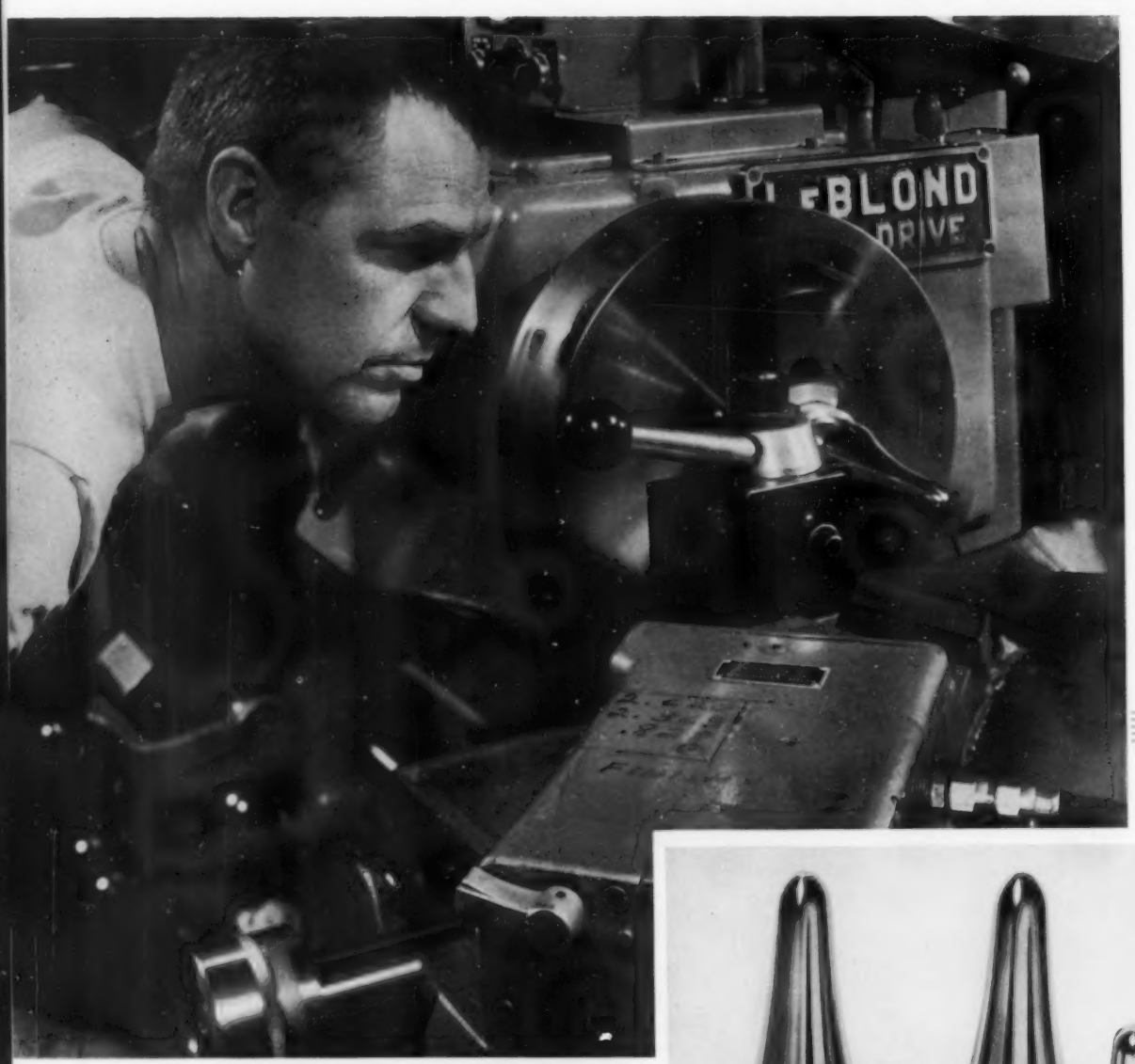
LARGE SECTIONS of a water supply system are welded without using conventional layouts at Steelweld Div. of the R. C. Mahon Co. Since they were too large to be drawn, the shapes were mathematically defined as one cylinder passing through another and calculated. Base lines, station lines and datum points were scribed directly on the flat stock. Automatic submerged arc welding was used to join the varying thicknesses of metal.

TOOLS at work



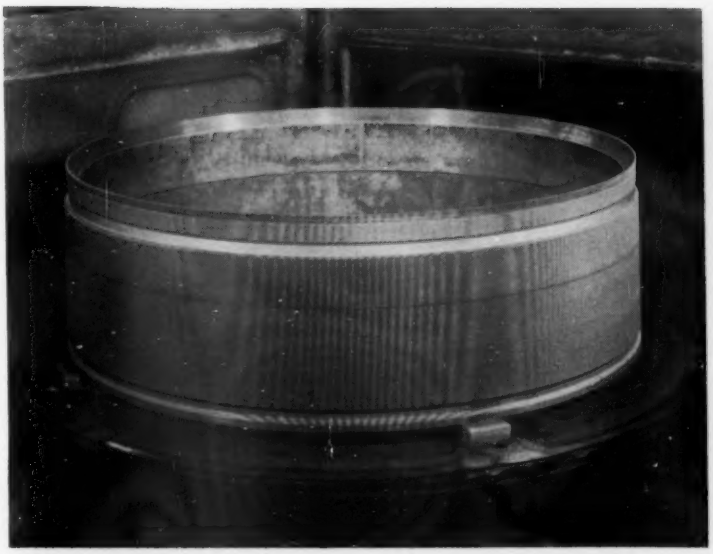
ALUMINUM SHEETS are automatically welded in a fusion seam welder as the operator monitors at the Grand Prairie plant of Temco Aircraft Corp. Horizontal and vertical movements are made with the boom in the position shown for welding curved and angled seams. By swinging the boom out over the tiltable turntable (at rear, in photo) circular seams can be welded at any angle. The inert gas shielded arc welder was modified by Temco to operate on alternating current as well as the direct current for which it was originally designed. The Weldtronic control system (behind turntable) governs torch heat, type of bead, and direction of welding head and torch holder travel.

VINYL-CLAD steel cabinet parts are welded to hinges, and braces without damage to the coating by magnetic force welding. The same current surge that brings the pieces to welding heat energizes a magnet to drive a hammer onto the weld projection. The weld is upset at the instant of maximum heat and so forged to a weld strength equalling AWS standards, yet is invisible from the side coated with paint, lacquer, veneer or vinyl. The welding machine was built by Precision Welder and Flexopress Corp.



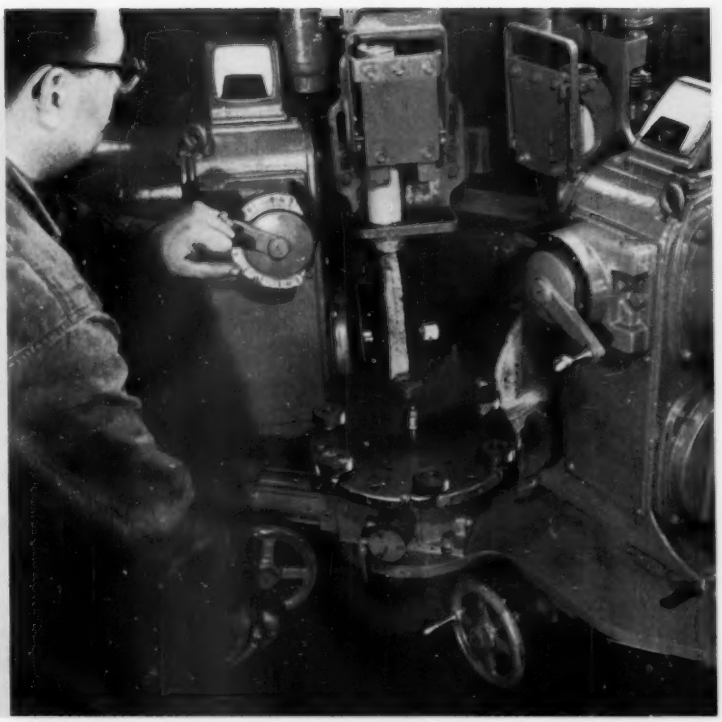
PLUNGERS FOR GLASS BOTTLE molds are contour turned to a 10 microinch finish on a production basis at Overmyer Mould Co. The steel plungers are flame sprayed with a refractory surfacing material whose hardness ranges from 57 to 59 R_c. Using cast iron grade carbide-tipped tools, the workpieces are machined in three passes. Spindle speed is steadily increased from 125 rpm to 1000 rpm during the pass to maintain a constant surface speed. A rigid lathe and sensitive tracer contribute to the production of the fine stepless surface finish. LeBlond dual drive lathes equipped with LeBlond tracers and Eaton constant speed drive controls are used to produce the plungers.

COMPLETE FINISHING and deburring of a large cylindrical knitting machine part is done in one operation in a wet blast cabinet at Jacquard Knitting Machine Co., Inc. All areas are uniformly blasted automatically to remove fine machine burrs in the slots, round off leading edges of the slot and blend all directional lines. The cabinet does the complete operation on the cylinder in 39 minutes. Up to three days were required previously, using manual blasting. The Liquamatte wet blast equipment is made by the Techline Div. of Wheelabrator Corp.



TOOLS at work

GEARS are polished and deburred at an annual cost savings of around $5000 at General Electric's gear motor and transmission components department. The gears, of C-1144 steel, range from 1⅝ to 3½ inches in OD and are brushed in 4 to 12 seconds, three times faster than the previous method. Tampco brushes with a 12-inch diameter and ½-inch width are used. Abrasive is mechanically fed to the brushes and an index table positions the gear under the brush. Polydyne adjustable speed drives rotate the brushes at an optimum speed, enabling the higher production rates with minimum brush wear.



TOOLS at work

BARS AND BILLETS are packaged in standard-shaped tight bundles under template control in the setup illustrated. Round billets are bundled hexagonally, square bars are stacked in square bundles. A powered roller conveyor (above) moves the stock from a prior operation to the pickup point where a lifter feeds the stock to a transfer arm. The transfer arm, actuated electrohydraulically under template control, then carries the billet and drops it into the proper place in the cradle.

This cycle is continued till the stack is complete (below). A tandem arrangement of the two bundling machines allows one bundle to be strapped and discharged while the next bundle is being built up on the other machine. The automatic bundling machine, made by Loma Machine Mfg. Co., Inc., can be changed over for different stock sizes in minutes by installing new templates.

how to apply

PNEUMATIC POWER

Part 3—Automation

By H. L. Stewart*
Logansport, Ind.

Simple hydraulic circuits, such as those described in Parts 1 and 2 of this series of articles, can be combined into complex automated circuits to effect foolproof movements of workpiece and tool.

WITH THE ADVENT of automation, many tool and manufacturing engineers are putting pneumatic power to work. By applying circuits of the type illustrated in this article, the inherent versatility and speed of pneumatic actuation can be used to move both workpiece and tool. Clamping, too, can be made automatic.

In designing circuits for automation, it is well to provide interlocks so that there is no possibility of one portion of the over-all circuit getting out of phase with another. Similarly, it is a good idea to make provisions for operating certain phases of the circuit with manual controls for the purpose of tool setting, positioning work carriages and tryout. There are several ways of doing this.

Some of the newer solenoid-operated four-way valves have push pins in the solenoid covers so that the setup man can operate the solenoids—and, in turn, the valve spool—without turning on the electric current. In solenoid bleeder pilot-operated controls that do not have push pins, two manual controls can be placed between the small two-way solenoid valve and the pilot-operated valve, as shown in *Fig.* 1. In solenoid pressure pilot-operated systems, *Fig.* 2, more valving and piping are required. In this type of circuit, shuttle valves, as well as three-way manually operated controls are used.

Versatile Circuit: The circuit shown in *Fig.* 3 can be applied as illustrated or with slight modifications for parts assembly, staking, marking, and drilling and broaching of small parts at high production rates. All components are made as compact as possible, because space is usually at a premium in fixtures or machines that perform these operations. Cylinders with solenoid valves built into the blind cylinder covers have the required compactness.

Referring to *Fig.* 3, the machine or fixture will function automatically as long as there are any parts in the hopper. When the part drops from the hopper onto the slide (station 1) it depresses the actuator of switch *LS*-1, which energizes solenoid *X*, shifting the spool of four-way valve *A*. Air is directed to the blind end of cylinder *D*. The piston of cylinder *D* advances, moving the workpiece out of the mouth of the hopper chute toward station 2. The cutoff device keeps the next workpiece from dropping out of the chute. Just before the workpiece is clamped in the fixture at station 2, a cam on the piston rod of cylinder *D* momentarily trips limit switch *LS*-3. Solenoid *W* of valve *B* is momentarily energized, shifting the spool, and air is directed to the blind end of staking cylinder *E*. Rapidly advancing, the piston performs the staking operation.

As staking is performed, switch *LS*-4 is contacted, causing solenoid *Z* to become energized. The spool of valve *B* is shifted to its original position, directing air to the bottom end of cylinder *E*, and the piston is rapidly retracted. During the retraction the roller of switch *LS*-5 is depressed by a cam on the tail rod of the cylinder. This cam—which is designed with a flat area—will only depress

*Senior member ASTME South Bend chapter.

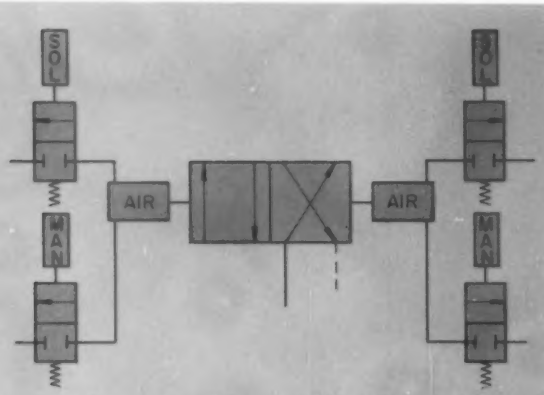


Fig. 1. Manual controls can be located to operated valves when current is turned off.

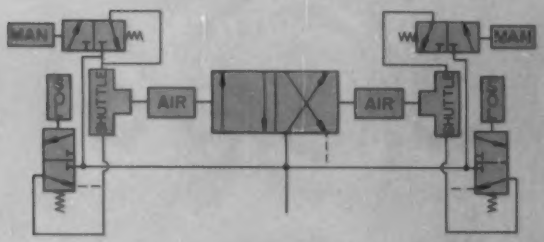


Fig. 2. For manual control during setup, this circuit has shuttle valves and three-way, manually operated valves.

the roller in one direction. When the roller is depressed, solenoid *S* of three-way valve *C* is energized, shifting the valve spool. Passage of air through the valve is blocked and the line between the blind end of cylinder *F* and valve *C* is open to exhaust. Since the bore of cylinder *D* is smaller than that of cylinder F, the piston of cylinder *D* cannot move the piston of cylinder *F* until air is released from the blind end of cylinder *F*. The pistons of both cylinders move at a speed set by flow control valve *H*.

As the workpiece is moved over the release chute, a cam on cylinder *F* trips roller of switch *LS*-2, which causes solenoid *Y* to become energized and shifts the spool of valve *A*. Air is directed to the rod end of cylinder *D*. Its piston retracts at a speed set by flow control valve *J* and the workpiece is dropped down the release chute.

When the piston of cylinder *D* reaches the retracted position, switch *LS*-6 is contacted and solenoid *R* is energized, shifting the spool of valve *C*. Air is directed to the blind end of cylinder *F* and its piston advances. At the extreme outstroke of the piston, the cam contacts normally open switch *LS*-7, which closes so that current can flow to switch *LS*-1. This is a safety measure so that the piston of cylinder *D* cannot advance before that of *F* has reached the extended position and stopped.

Cylinder *D* can accurately position the workpiece even though its piston has not reached the end of the stroke. This eliminates the need for a three-position valve and provides the required holding force in the intermediate position. Valve *G* can be used advantageously to change the line pressure to take care of materials of different densities. A simple screw adjustment can control the pressure to the cylinder from zero to the full line pressure. The check valve is used since many reducing valves are suitable for flow in only one direction.

If cylinder *E* is used to control the movement of a drill, an air-hydraulic cylinder can do a satisfactory job. It can be equipped for rapid approach, feed and rapid retraction. If cylinder *E* is used to perform an operation on a blind hole where the depth must be accurately controlled, it can be equipped with a stroke adjustment feature. The length of stroke can then be accurately controlled for an infinite number of depths up to the full stroke of the cylinder. The design is usually a screw-and-handwheel arrangement and is locked at the desired setting. Cylinder *F* can be equipped with a stroke adjustment to accommodate various workpiece sizes. If stroke adjustments are used on cylinders *E* and *F*, provision should be made for repositioning the limit switches or for using adjustable cams on the piston rods, or perhaps a combination of both.

In the line between valve *G* and top end of cylinder *E* it may be desirable to use a pressure switch and eliminate limit switch *LS*-4. This would also eliminate the use of one cam on the tail rod of cylinder *E*. The contacts in the pressure switch will close and cause solenoid *Z* to become energized when pressure builds up at the end of the stroke. The piston of cylinder *E* will immediately retract.

Multipurpose Circuit: Another basic circuit is shown in *Fig.* 4. In an application where the workpiece must be positioned twice and work is performed at each position, this circuit has many possibilities. When the workpiece is dropped into station 1, (this can be done by chute, by a positioner or by a transfer mechanism) switch *LS*-1 is contacted, which energizes solenoid *N* of valve *A*. The valve spool, shifts, directing air to port *AA* of cylinder *J*. The cylinder tube advances, since the rod in the back section is stationary. The cylinder moves the workpiece to station 2 at a speed controlled by flow control valve *V*. Since the end of the cylinder comes to a positive stop against the piston, the workpiece is accurately positioned.

Just before station 2 is reached, a cam on the tube of cylinder *J* is depressed and rides over the roller of limit switch *LS*-6, which momentarily energizes solenoid *Q* of valve *C*. The valve spool

is shifted, directing air to port *FF* of cylinder *K* and the piston advances, clamping the workpiece. Pressure then builds up and sequence valve *E* opens. Pressure is directed to port *HH* of cylinder *K* and the tool cylinder advances, performing the work.

At the end of the work stroke, a cam on the tail rod of cylinder *K* depresses the roller of limit switch *LS*-4. Solenoid *R* of valve *C* is energized, causing the spool to shift. Air is directed to port *GG* and tool cylinder piston retracts. As the piston reaches the retracted position, pressure builds up, opening sequence valve *F*. Air moves to port *EE*, causing the piston of the clamp cylinder to retract. As the piston rod approaches the retracted position, a cam contacts the roller of limit switch *LS*-2. This energizes solenoid *O* of valve *B*. Air is then directed to port *CC* of cylinder *J* and its piston advances, moving the workpiece to station 3 at a speed controlled by valve *W*.

As switch *LS*-7 is tripped, solenoid *S* of valve *D* is energized and the same sequence of operations takes place as when solenoid *Q* of valve *C* was energized. When the piston rod on the clamp section of cylinder *L* retracts, the roller of switch *LS*-3 is contacted. Solenoids *M* and *P* of valves *A* and *B* respectively are energized and the spools of both valves shift. The pistons of cylinder *J* move to their retracted positions, completing the cycle. On the next cycle the workpiece that is at station 3 will be advanced to a conveyor as a second workpiece is moved into station 3.

In this circuit, sequence valves should be eliminated if there is excessive fluctuation in the line pressure. The double-rod cylinder permits a compact installation and makes it possible to apply force directly over the workpiece, which is often desirable. The disadvantage of this type of cylinder is that it is more difficult to service, due to the added packing required. The cylinders can be positioned for setup purposes by contacting the push pins in the solenoids.

Pressure Test Circuit: The circuit shown in *Fig.* 5 has a number of uses in testing or gaging where it is necessary to have an operator present for visual inspection. In this application the operator or inspector is pressure testing the workpiece with a liquid. To start the operation in motion, the workpiece (which in this case is loaded into a dial type indexing fixture) drops into the slot in the fixture and depresses the roller on limit switch *LS*-1. There is no action, however, until the operator depresses pushbutton *PB*-1. The circuit is designed in this manner so that the operator must be at the machine when it starts through the cycle.

When the pushbutton is depressed, solenoid *X* of valve *H* is energized. This causes air to be directed to the blind end of ratchet index cylinder *C* and the fixture is indexed 90 deg. As this is done, limit switch *LS*-2 is momentarily contacted. Solenoid *R* of valve *G* is momentarily energized and air is directed to port *AA* of cylinder A. The piston of cylinder *A* advances, placing a plug in the end of the workpiece. As the plug is positioned, limit switch *LS*-3 is momentarily tripped by a cam on the

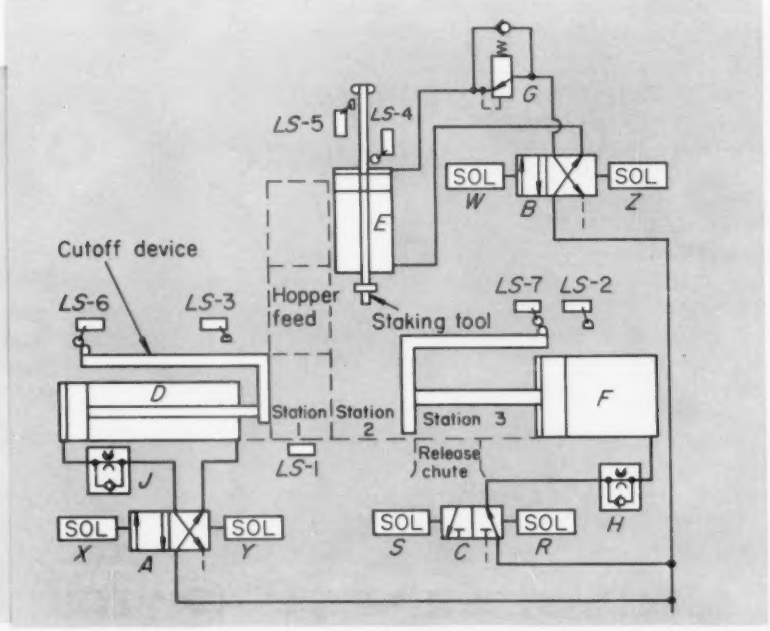


Fig. 3. Circuit for automatic staking operation workpiece is dropped into station 1 from a chute, moved to station 2 for staking, staked, then moved to station 3 for ejection.

tail rod of cylinder *A*, solenoid *T* is energized and air is directed to port *DD* of cylinder *B*. The piston of cylinder *B* advances, placing a plug in the opposite end of the workpiece. A test light turns on when the plug is seated. This shows the operator that he can perform the test.

The operator depresses pushbutton *PB*-3, which energizes solenoid *Q* of valve *F*, and the passage through this valve opens. If water is the medium used for test, the line to valve *F* will be connected to the city water line. If some other fluid is used, a small pump can be placed in the line. The fluid will unseat the check in valve *Z* and flow through hollow rod of cylinder *B* into the workpiece, then through valve *E* and on to the reservoir.

When the operator sees that the air is out of the line, he depresses pushbutton *PB*-2, energizing solenoid *P*, and valve *E* closes. He then depresses *PB*-3, which energizes solenoid *M* of valve *K*. Air is directed to the blind end of air-operated intensifier *D*.

This intensifier is built as an air cylinder that has a fluid chamber on one end. The fluid pressure can be greatly intensified, depending upon the area ratio between the air cylinder and the fluid ram. For example, if the ratio is 50 to 1 and the air-line pressure is 90 psi, the theoretical pressure from the intensifier would be 4500 psi.

The intensifier piston advances and the operator checks the reading on pressure gage *SS*. Then the operator depresses pushbutton *PB*-4, which energizes solenoid *N* of valve *K*. Air is directed to the rod end of cylinder *D* and the piston retracts. Next, the operator presses pushbutton *PB*-3 and valve *F* closes. He then presses pushbutton *PB*-2 and valve *E* opens. Next he momentarily depresses release button *PB*-5, which energizes solenoid *S* and solenoid *V* of valves *G* and *J* respectively. The pistons of cylinders *A* and *B* retract. Since the retraction of cylinder *B* is limited by flow control valve *DD* it will reach the retracted position later than the piston of cylinder *A*. A cam on the rod of cylinder *B* will momentarily depress the roller of limit switch *LS*-4. This causes solenoid *Y* of valve *H* to be energized. Air is directed to the rod end of cylinder *C* and the piston retracts. The index table will not move, however, since there is a ratchet mechanism that allows indexing in one direction only. Depressing pushbutton *PB*-1 starts the cycle again by indexing the table.

In this circuit limit switch *LS*-1 is used so that the index mechanism cannot advance until the workpiece is properly seated. This is a precautionary measure that probably could be eliminated where the operator has a clear view of the workpiece, but the advantage certainly warrants the small extra expense.

Hollow-rod cylinders such as cylinder *B* are used quite frequently in pneumatic applications. The hollow rod provides passage for coolants, plungers and materials such as metal bars. If it were desirable to rid the fixture of fluid before the plugs are released from the workpiece, an air pressure connection could be located on the plug operated by cylinder *B* and the passage through the rod could be equipped with a check. When valve *E* was opened, the operator could shoot a stream of compressed air through the workpiece and the fluid would go to the reservoir. This inexpensive addition would eliminate a messy condition.

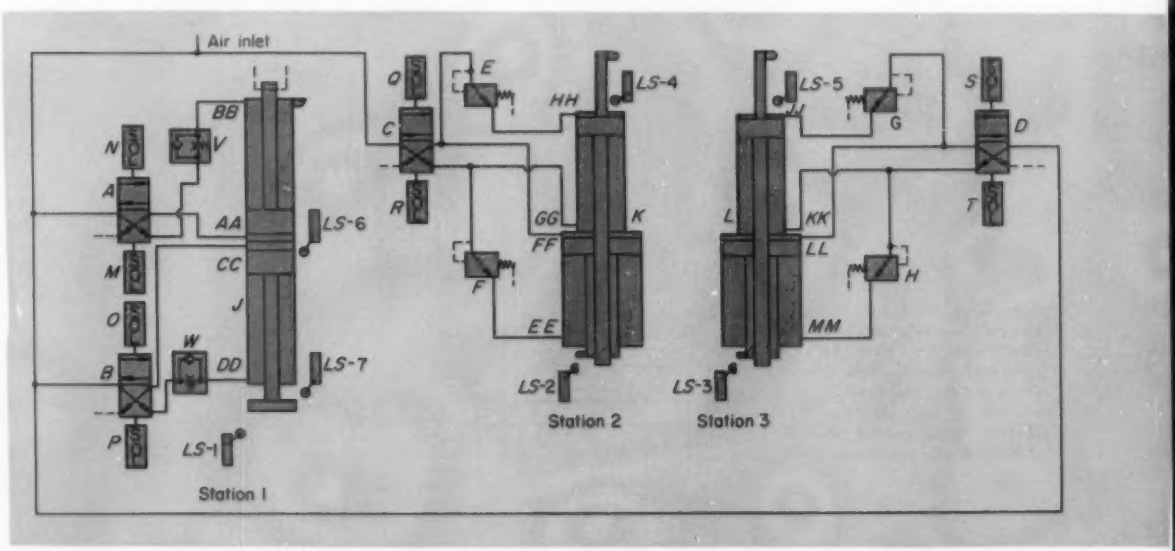


Fig. 4. This circuit transfers and clamps workpiece, performs staking or similar operation. Hoses from valves *A* and *B* to ports *AA*, *BB*, *CC* and *DD* are flexible to permit movement.

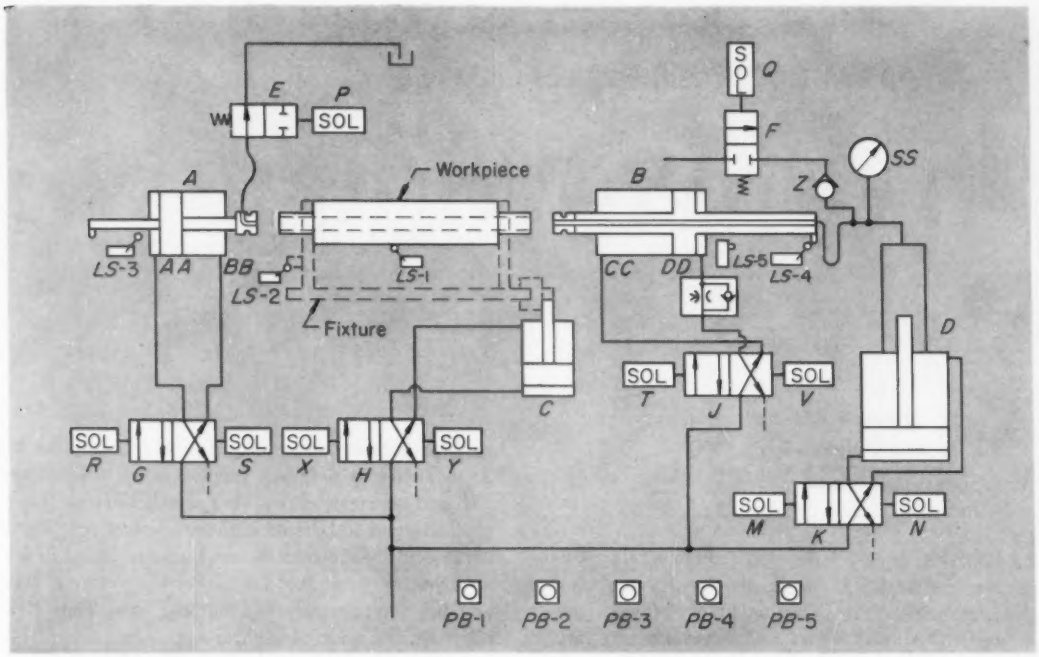


Fig. 5. Circuit for pressure testing. Liquid is pumped through hollow rod of cylinder *B* to desired pressure.

By the addition of another cylinder and valve, any rejected workpieces could be moved to a rejection station after being dropped out of the indexing fixture.

The air-operated hydraulic intensifier (item *D* on the figure) has other applications in production processes. For example it is widely used to expand the tubes used in cooling systems. The tube is passed through a number of fins, which are securely held, then the intensified pressure is put into the tube to expand it out against the fins. This operation eliminates the use of long sizing tools. Complicated tube bends can be expanded with the pressure method where expansion with a sizing tool is impractical. Another application is operating small punches where space is at a minimum. Here the high pressure from the intensifier actuates small-bore cylinders attached to the punch.

Air-operated intensifiers are cheaper than hydraulic power devices for producing the same pressure. Heating problems are eliminated, as is fluid leakage.

To sum up: Pneumatic power is versatile and lends itself well to automated production. To obtain maximum benefits, the circuit designer should make the circuits as simple as possible, eliminating all unnecessary valving. He should keep in mind the safety of the operator, the machine and the workpiece, and should locate components so that they are easily accessible for maintenance. And, last but not least, he should select components that are fully reliable, remembering that inferior components are costly when they break down in service.

Organic Compounds Increase Fatigue Strength of Metals

The National Bureau of Standards has recently investigated the effects of polar and nonpolar organic compounds on metal fatigue. Experiments showed that coatings of long-chain polar substances greatly increase the fatigue strengths of steel, magnesium and copper-beryllium alloys.

It is well-known that mild corrosion effects fatigue strength. On metal surfaces, the polar compounds apparently form tightly packed monolayers that act as a barrier to water and oxygen molecules.

The polar compounds tested included octyl alcohol, dodecyl alcohol, dodecylamine and octadecylamine. These compounds caused an increase of over 600 percent in the fatigue life of magnesium alloy stressed at 12,500 psi; an increase of approximately 250 percent in a copper-beryllium alloy, stressed at 50,000 psi; and an increase of approximately 200 percent in a steel alloy, stressed at 100,000 psi. The compounds had little beneficial effect on titanium, aluminum and stainless steel.

how to estimate
BANDSAWING COSTS

By Joseph Gliebe

Method and Standards Chief
National Acme Co.
Cleveland, Ohio

BANDSAWS, once restricted to rough straight-line parting and slotting operations, have taken their place in industry as versatile, highly efficient machines. At National Acme, complex contoured parts of the type shown in *Fig.* 1 are bandsawed to tolerances of ±0.015 inch on a production basis.

To obtain optimum productivity, bandsawing operations are time-studied when the length of production runs permits. For estimating purposes, a simple formula, based on time study data, is used to obtain an idea of production time and cost.

Where B is band machining time, minutes, A is the total area cut in square inches, K is a machining factor depending on the type of cut and C is the number of cuts,

$$B = AK + 3C$$

This formula includes allowances for contingencies such as personal time, fatigue and minor machine adjustments. It does not include setup allowances.

Based on experience with a DoAll Contour-matic machine and a Demon high-speed steel saw band cutting SAE 4150 steel, K was found to be 0.375 for straight-line cuts, 0.5 for power-fed contour cuts and 0.6 for manually fed contour cuts. Thus if a job requires seven straight-line cuts, totalling 100 square inches of cut, $B = (100 \times 0.375) + (3 \times 7) = 58.5$ minutes. Similarly, for one power-fed contouring cut of 20 square inches, $B = (20 \times 0.5) + (3 \times 1) = 13$ minutes. Time required to complete three manually fed contour cuts totalling 20 square inches is estimated at 21 minutes.

Different steels, nonferrous materials and different saw blades require different values for K. These can be determined empirically. By adding the fixed amounts of time allotted for job setup and changeover, floor-to-floor time is readily calculated. To eliminate calculation by estimators, values can be charted for quick reference as shown in *Fig.* 2.

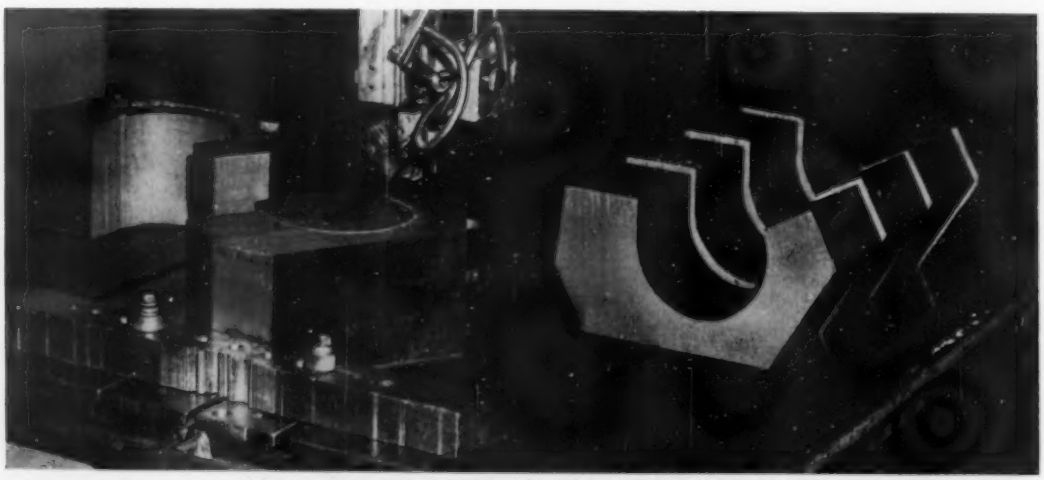


Fig. 1. Knee turners are band machined to ±0.015 inch in 64 minutes. The only fixturing required is a backup bar.

STANDARD TIME VALUES FOR BANDSAWING (min)*

Area of Cutting (sq in.)	Straight-Line Cutting, Power Feed												Contour Cutting, Power Feed			Contour Cutting, Manual Feed		
	Number of Separate Cuts per Piece																	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	1	2	3
2	3.8	6.8	9.8	12.8	15.8	18.8	21.8	24.8	27.8	30.8	33.8	36.8	4.0	7.0	10.0	4.2	7.2	10.2
4	4.5	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	5.0	8.0	11.0	5.4	8.4	11.4
6	5.3	8.3	11.3	14.3	17.3	20.3	23.3	26.3	29.3	32.3	35.3	38.3	6.0	9.0	12.0	6.6	9.6	12.6
8	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	7.0	10.0	13.0	7.8	10.8	13.8
10	6.8	9.8	12.8	15.8	18.8	21.8	24.8	27.8	30.8	33.8	36.8	39.8	8.0	11.0	14.0	9.0	12.0	15.0
12	7.5	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	9.0	12.0	15.0	10.2	13.2	16.2
14	8.3	11.3	14.3	17.3	20.3	23.3	26.3	29.3	32.3	35.3	38.3	41.3	10.0	13.0	16.0	11.4	14.4	17.4
16	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	42.0	11.0	14.0	17.0	12.6	15.6	18.6
18	9.8	12.8	15.8	18.8	21.8	24.8	27.8	30.8	33.8	36.8	39.8	42.8	12.0	15.0	18.0	13.8	16.8	19.8
20	10.5	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	13.0	16.0	19.0	15.0	18.0	21.0
22	11.3	14.3	17.3	20.3	23.3	26.3	29.3	32.3	35.3	38.3	41.3	44.3	14.0	17.0	20.0	16.2	19.2	22.2
24	12.0	15.0	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	42.0	45.0	15.0	18.0	21.0	17.4	20.4	23.4
26	12.8	15.8	18.8	21.8	24.8	27.8	30.8	32.8	36.8	39.8	42.8	45.8	16.0	19.0	22.0	18.6	21.6	24.6
28	13.5	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	17.0	20.0	23.0	19.8	22.8	25.8
30	14.3	17.3	20.3	23.3	26.3	29.3	32.3	35.3	38.3	41.3	44.3	47.3	18.0	21.0	24.0	21.0	24.0	27.0
32	15.0	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	40.0	45.0	48.0	19.0	22.0	25.0	22.2	25.2	28.2
34	15.8	18.8	21.8	24.8	27.8	30.8	33.8	36.8	39.8	42.8	45.8	48.8	20.0	23.0	26.0	23.4	26.4	29.4
36	16.5	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	49.5	21.0	24.0	27.0	24.6	27.6	30.6
38	17.3	20.3	23.3	26.3	29.3	32.3	35.3	38.3	41.3	44.3	47.3	50.3	22.0	25.0	28.0	25.8	28.8	31.8
40	18.0	21.0	24.0	27.0	30.0	33.0	36.0	39.0	42.0	45.0	48.0	51.0	23.0	26.0	29.0	27.0	30.0	33.0
42	18.8	21.8	24.8	27.8	30.8	33.8	36.8	39.8	42.8	45.8	48.8	51.8	24.0	27.0	30.0	28.2	31.2	34.3
44	19.5	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	49.5	52.5	25.0	28.0	31.0	29.4	32.4	35.4
46	20.3	23.3	26.3	29.3	32.3	35.3	38.3	41.3	44.3	47.3	50.3	53.3	26.0	29.0	32.0	30.6	33.6	36.6
48	21.0	24.0	27.0	30.0	33.0	36.0	39.0	42.0	45.0	48.0	51.0	54.0	27.0	30.0	33.0	31.9	34.9	37.9
50	21.8	24.8	27.8	30.8	33.8	36.8	39.8	42.8	45.8	48.8	51.8	54.8	28.0	31.9	34.0	33.0	36.0	39.0
52	22.5	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	49.5	52.5	55.5	29.0	32.0	35.0	34.2	37.2	40.2
54	23.3	26.3	29.3	32.3	35.3	38.3	41.3	44.3	47.3	50.3	53.3	56.3	30.0	33.0	36.0	35.4	38.4	41.4
56	24.0	27.0	30.0	33.0	36.0	39.0	42.0	45.0	48.0	51.0	54.0	57.0	31.0	34.0	37.0	36.6	39.6	42.6
58	24.7	27.7	30.7	33.7	36.7	39.7	42.7	45.7	48.7	51.7	54.7	57.7	32.0	35.0	38.0	37.8	40.8	43.8
60	25.5	28.5	31.5	34.5	37.5	40.5	43.5	46.5	49.5	52.5	55.5	58.5	33.0	36.0	39.0	39.0	41.0	44.0
65	27.4	30.4	33.4	36.4	39.4	42.4	45.4	48.4	51.4	54.4	57.4	60.4	36.0	39.0	42.0	42.0	45.0	48.0
70	29.3	32.3	35.3	38.3	41.3	44.3	47.3	50.3	53.5	56.3	59.3	62.3	38.0	41.0	44.0	45.0	48.0	51.0
75	31.1	34.1	37.1	40.1	43.1	46.1	49.1	52.1	55.1	58.1	61.1	64.1	40.0	43.0	46.0	48.0	51.0	54.0
80	33.0	36.0	39.0	42.0	45.0	48.0	51.0	54.0	57.0	60.0	63.0	66.0	43.0	46.0	49.0	51.0	54.0	57.0
85	35.0	38.0	41.0	44.0	47.0	50.0	53.0	56.0	59.0	62.0	65.0	68.0	45.0	48.0	51.0	54.0	57.0	60.0
90	37.8	40.8	43.8	46.8	49.8	52.8	55.8	58.8	61.8	64.8	67.8	70.0	48.0	51.0	54.0	57.0	60.0	63.0
95	39.6	42.6	45.6	48.6	51.6	54.6	57.6	60.6	63.6	66.6	69.6	72.6	50.0	53.0	56.0	60.0	63.0	66.0
100	40.5	43.5	46.5	49.5	52.5	55.5	58.5	61.5	64.5	67.5	70.5	73.5	53.0	56.0	59.0	63.0	66.0	69.0
105	42.4	45.4	48.4	51.4	54.4	57.4	60.4	63.4	66.4	69.4	72.4	75.4	55.0	58.0	61.0	66.0	69.0	72.0
110	44.3	47.3	50.3	53.5	56.3	59.3	62.3	65.3	68.3	71.3	74.3	77.3	58.0	61.0	64.0	69.0	72.0	75.0
115	46.0	49.0	62.0	55.0	58.0	61.0	64.0	67.0	70.0	73.0	76.0	79.0	60.0	63.0	66.0	72.0	75.0	78.0
120	48.0	51.0	54.0	57.0	60.0	63.0	66.0	69.0	72.0	75.0	78.0	81.0	63.0	66.0	69.0	75.0	78.0	81.0
125	49.8	52.8	55.8	58.8	61.8	64.8	67.8	70.8	73.8	76.8	79.8	82.8	65.0	68.0	71.0	78.0	81.0	84.0
130	51.8	54.8	57.8	60.8	63.8	66.8	69.8	72.8	75.8	78.8	81.8	84.8	68.0	71.0	74.0	81.0	84.0	87.0
135	53.8	56.8	59.8	62.8	65.8	68.8	71.8	74.8	77.8	80.8	83.8	86.6	70.0	73.0	76.0	84.0	87.0	90.0
140	55.5	58.5	61.5	64.5	67.5	70.5	73.5	76.5	79.5	82.5	85.5	88.5	73.0	76.0	79.0	87.0	90.0	93.0
145	57.5	60.5	63.5	66.5	69.6	72.5	75.5	78.5	81.5	84.5	87.5	90.5	75.0	78.0	81.0	90.0	93.0	96.0
150	59.2	62.2	65.2	68.2	71.2	74.2	77.2	80.2	83.2	86.2	89.2	92.2	78.0	81.0	84.0	93.0	96.0	99.0

*Based on high-speed steel saw band cutting SAE 4150 steel.

STANDARD SETUP TIME:

Changing saw band	5.0	Set up work squaring bar	3.0
Changing saw guides	5.0	Set up work holding vise	2.0
Changing jobs (includes time to get fixture and set up)	5.0	Set up work on angle plate	3.0
		Set table travel stops	1.0

Fig. 2. Quick reference chart of band machining time eliminates calculation by estimators.

how to cut TOOL and

Part 1—Shop Practice

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Substantial savings in the manufacturing costs of tools and dies are attained when certain departures from conventional practice are made. In this article, the first of four on this subject, the author explains the role the shop can play in effecting these economies.

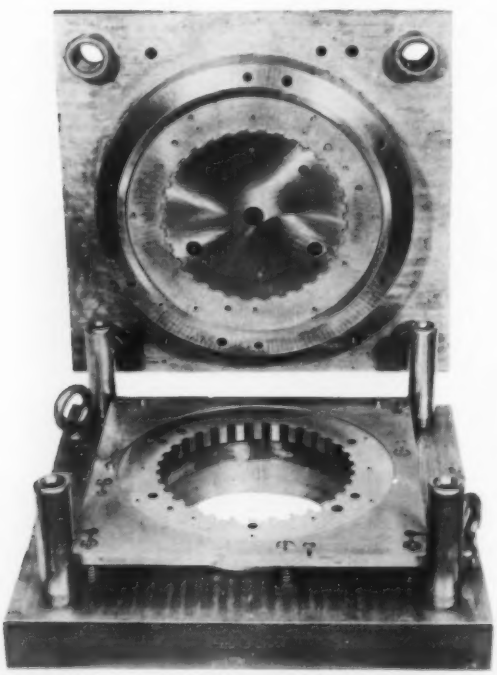

Fig. 1. Compound die for blanking and piercing friction rings was finish machined in soft condition.

TOOL AND DIES COSTS, now at an all time high, can be reduced if certain procedures in tool manufacturing and heat treatment are observed. These include the finishing of tool and die components in the annealed state and the preservation of their dimensional integrity throughout heat treatment. Although this is well-established practice in rough tooling, it can now be adapted to precision tools such as the die illustrated in *Fig.* 1.

This advance in tool and die making technique has been made possible by improved tool steels and modern furnace techniques. The economies it obtains accrue from reduced machining requirements and the omission of reworking operations after hardening.

Machining Time: One of the most effective ways of reducing tool and die costs is to finish contours and configurations in the annealed state. This applies not only to clean-up of flat surfaces but to many operations which are usually performed after hardening.

A good example of this technique is seen in the drill fixture illustrated in *Fig.* 2. Normally, threaded bushings and liners in fixtures of this type are water-hardening tool steel, and the threads are ground after heat treatment. From a service viewpoint, water-hardening tool steel is satisfactory in this application because the bushings stand up very well under prolonged usage. However, the substitution of air-hardening tool steel—a relatively stable material—enables the toolmaker to cut the threads to finish size. Subsequent grinding and lapping operations can be omitted and assembly can be made immediately after hardening. Savings in machining costs are at least 50 percent.

In diemaking, many methods of reducing machining costs are available. In making pierce dies, for example, the toolmaker can lay out holes in the pad and make both the pad and die in one operation. This technique is economical but there is an ever-present risk of distortion in the pad during heat treatment. Generally a slight distor-

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DIE costs

tion or size change will ruin this component. However, the risk of even minor distortion can be minimized if care is taken in the selection of tool steel.

The die shown in *Fig.* 3 is a good example of the possibilities of this technique. Used in the manufacture of radios, this die pierces 194 different holes in the chassis. Because of the close proximity of the holes, it is necessary to accomplish the piercing operation in two stages within a single die.

In this application an air-tough steel was selected and all holes were machined to finish size. After heat treatment, the die plates were measured for distortion and found to be within 0.002 inch of their original size and shape. This relatively small discrepancy was corrected by surface grinding. The pad, which was made simultaneously with the die plates, fitted the die without the need of corrective machining.

Another opportunity to reduce machining costs lies in the use of one-piece die plates instead of conventionally sectionalized dies. Among the advantages of this method are the decreased chances of diemaking error, more operations per setup, fewer parts to heat treat and the elimination of adjustment between sections.

A good example of the possibilities inherent in unitized construction is shown in *Fig.* 4. As in the preceding example, *Fig.* 3, this unitized die is especially vulnerable to distortion because of the large number of holes, the sharp corners of its cutouts, and the thin section milled on one side of the plate.

Time To Reach Drawing Temperature

Drawing Temperature (F)	Cubes or Spheres (min/in. thick)	Long Squares or Cylinders (min/in. thick)	Average Flat Tools (min/in. thick)
Without Forced Circulation			
300	30	50	90
400	25	45	65
500	25	40	60
700	20	35	50
900	20	30	40
With Forced Circulation			
300	15	20	30
400	15	20	30
500	15	20	30
700	15	20	30
900	15	20	30

Dimensionally, all hole locations are critical. The cutout holes are retainers for form inserts and the smaller round holes are used for piloting. Here again, proper selection of die steel is most important. Many dies which are made in sections to eliminate distortion, size change and cracking could be made more economically if low-distortion materials—air-tough or air-hardening steel—were used.

Rework: On some jobs all finish grinding can be eliminated although working limits are exceptionally close. As an example, the dies illustrated in *Fig.* 6 are used to trim 0.003 inch rigid aluminum foils for the food-packaging industry. To eliminate grinding after heat treatment, the tool room was instructed to finish the dies and punches with skin-fit mating. An A-6 type steel was used. After preliminary stress relief and normal heat treatment, the die sections and draw rings were inspected and found to be within 0.0003 to 0.0004 inch of finished size. No finish grinding was re-

Fig. 2. Sectional view of drill fixture. Threaded bushing holds drill bushing and locates part.

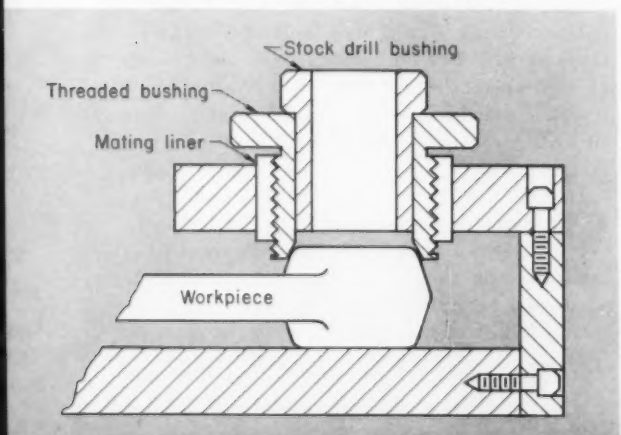
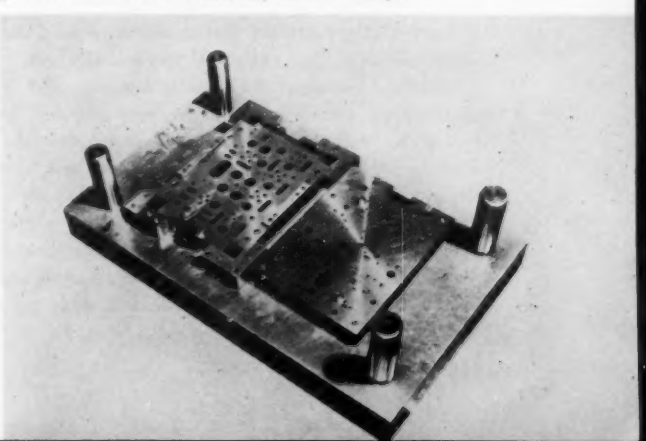
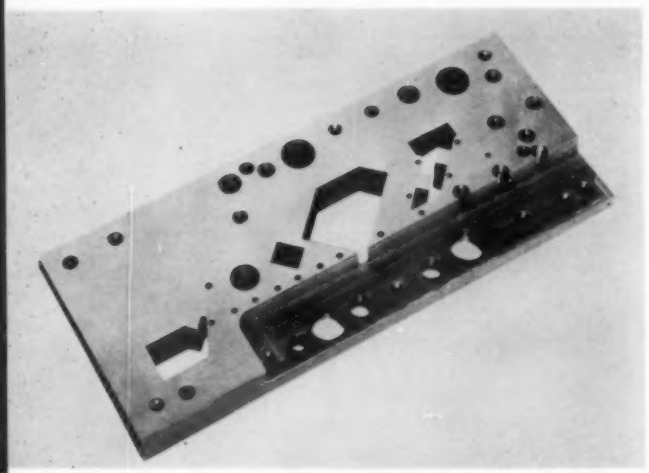


Fig. 3. Die for piercing holes. Complexity of hole pattern makes double die layout necessary.





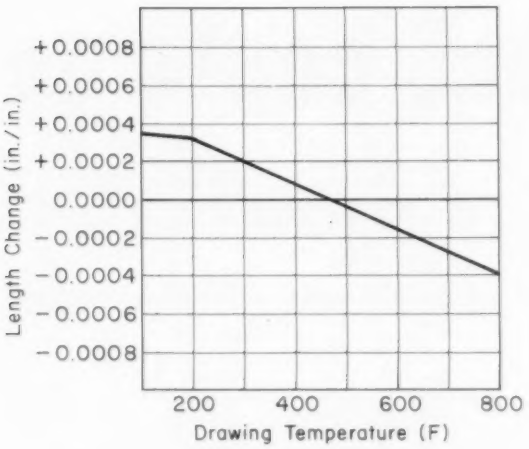


Fig. 4. (Upper left) Plate used as basic component in progressive die. Irregular holes are for insertion of form sections.

Fig. 5. (above) Dimensional changes induced by drawing temperature.

Fig. 6. (left) Components of dies for trimming aluminum foil. Punches, at bottom, are metal-to-metal fit with dies.

quired and the die was assembled immediately after inspection.

Another example of a complicated die which was finished soft and assembled without rework is shown in *Fig.* 1. This is a compound die for piercing and notching friction rings. Made of air-hardening steel, the punch and die mated perfectly after hardening. No grinding was required.

Part Deformation: Deformation in tool and die components is caused by the initial shock of quenching. In most cases, it is accompanied by dimensional changes, although these can be corrected by subsequent draw operations. Because drawing does not correct warpage, the best solution to the problems it creates is in selection of a nondeforming steel. Usually deformation is most pronounced in water-hardening tool steel. Considerably less is encountered in oil-hardening steels and practically none at all in air-hardening steels.

Heat Treatment: Maintenance on nondeforming characteristics is dependent upon proper heat treatment regardless of which type of steel is selected. This includes both the hardening and draw temperatures. For example, AISI type D2 steel will show characteristics of shrinkage, softness and loss of magnetic properties if hardened at a temperature above the correct range of 1825 to 1875 F. As shown in *Fig.* 5, this steel will have size change within 0.0003 inch if drawn between 400 and 700 F.

A correct furnace atmosphere is essential. Modern controlled-atmosphere heating equipment and neutral salt baths used in tool hardening effectively reduce scaling and surface decarburization. When a simple gas-fired furnace is used, its atmosphere should be slightly oxidizing at temperatures below 1700 F. At temperatures above 1700 F, pack hardening is recommended.

Soaking time is also important. Any attempt to reduce required soaking time is usually disastrous. However, a tool or die component can be brought up to temperature safely, and with greater speed, if certain practices are observed. For example, lazy circulation can reduce the time required for a part to reach 1450 F from 50 to 38 minutes. Active circulation will further reduce the time to 30 minutes. The same principle is true in hot-air tempering ovens. As shown in the table, the time required to reach drawing temperature can be reduced 25 to 65 percent by active circulation.

determining Decarburization Depth —Nondestructively

By Frank Phillips
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Using standard testing equipment, decarburization depths can be determined nondestructively more consistently than by destructive methods. Core and surface hardness readings are converted to decarburization depth indications by using a nomograph.

DECARBURIZATION DEPTH in steel parts—a zone of carbon depletion extending from the surface to a depth of a few thousandths of an inch—is difficult to determine. The zone gradually increases to a relatively stable value in the core and as a result of the gradual change in carbon concentration it is difficult to define the end point of the decarburization zone. The two methods currently used for detecting the condition are the visual method and the microhardness method, both destructive. This, and certain other disadvantages of the two available methods led the Quality Control Laboratory at Boeing Airplane Co. to seek an improved and nondestructive means of determining the depth of decarburization.

The method devised avoids the inconsistent results obtained by the visual method, is as reliable as the microhardeness method and has the advantage of being nondestructive and considerably faster. Using an in-tolerance Rockwell Tester, a trained operator determines surface and core hardness values, *Fig.* 1. These values are converted to depth readings by use of the nomograph.

Fig. 1. Using standard test equipment, an operator can quickly determine decarburization depth.

Obtaining Standard Readings: To use the nomograph with any given tester, two conditions must be met. First, the tester must be accurate to ± 1.0 R_c. This can be determined by taking six separate R_c values on each of two standard blocks that have hardnesses of approximately 25 and 65 R_c. If the last three readings for each block are within ± 1.0 R_c of the value written on the standard block, the tester is in tolerance. Any tester not within tolerance is unsuitable for use in this method and must be adjusted.

Second, a correction graph must be made to convert individual tester values to standard conditions. The graph, shown in *Fig.* 2, is prepared in the following manner:

1. Using the R_c 25 block, obtain surface and core hardness values. Read R_1 using the 60-kg load on

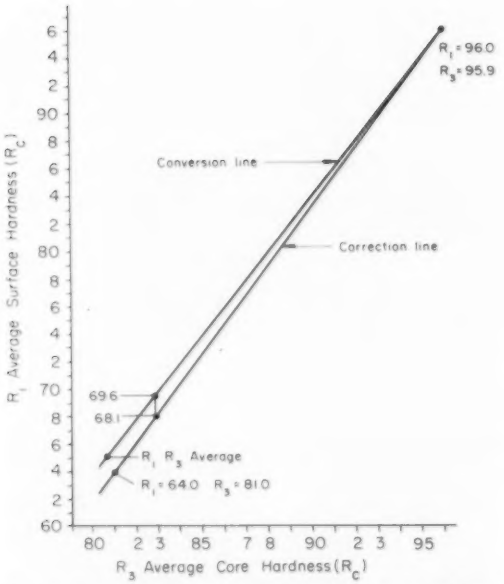

Fig. 2. To compensate for differences in individual testers, a correction graph is made.

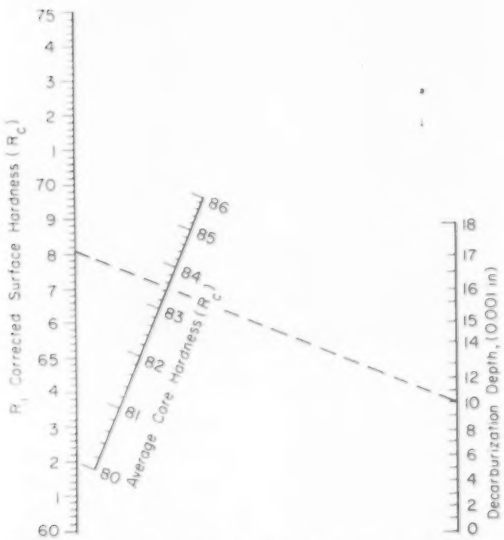

Fig. 3. Core and surface hardness values indicate decarburization depth by conversion.

the indentor for 30 seconds. Record the reading to the nearest tenth. Do not remove the part from the tester.

2. Place the 40-kg weight on the tester so that the total load is 100 kg. Turn the elevating screw to make the indicator return to the minor load position. Make the final zero adjustment using the zero-minder. Take the second reading, R_3 as described in Step 1. Do not remove the part from the tester.
3. Place the 50-kg weight on the tester so that the total load is 150 kg. Read and record R_3 as previously described and remove the part from the tester.
4. Repeat Steps 1, 2 and 3 six times. If the range of either the six R_1 values or the six R_3 values exceeds 0.3, disregard these six sets of values and obtain six new sets. Failure to obtain satisfactory sets of values could be caused by a faulty tester or block. The values must be within the stated range to continue the procedure.
5. Average the six R_1 and the six R_3 values to one-tenth accuracy. Divide R_1, average by R_3, average. If the ratio is less than 0.7690, the correlation to the nomograph is not valid. Changing the indentor or increasing the minor load should produce an acceptable ratio. The ratio condition must be satisfied before proceeding.
6. Construct a correction graph as shown in *Fig.* 2. Locate one point at coordinates 64.0, 81.0 and a second point at 96.0, 95.9. Draw a straight line between the points. This is the standard correction line. Locate a third point whose R_1 and R_3 coordinates are the averages obtained in Step 5. Draw a straight line from this point to the point located at 96.0, 95.9. This is the conversion line.

Making Decarburization Measurements: When the correction graph has been completed for an in-tolerance tester, it is possible to convert individual tester readings to the correction standard and thus to use the nomograph, *Fig.* 3. Taking the core and surface readings is relatively easy.

1. Obtain three sets of R_1 and R_3 values as previously described. The range should not exceed 0.6. If it does, take three additional sets of values. Average the six R_1 and the six R_3 values.
2. To convert this R_1 average reading to the corrected reading, use the correction graph. Locate R_1 average on the conversion line and draw a vertical line from this point till it intersects the correction line. R_1 value at the intersection is the corrected R_1 value, one of the scales on the nomograph.
4. On the nomograph, locate the corrected R_1 value and the R_3 value. Extend a straight line through these points to intersect the decarburization depth scale, where this value can now be read.

An example of the method is shown on the correction graph and the nomograph. Using a standard block, average values determined for R_1 and R_3 were 64.5 and 80.4. This point was located on the correction graph, and the conversion line drawn. On the workpiece being examined, average values for R_1 and R_3 were 69.6 and 83.5, respectively. As shown in *Fig.* 2, the R_1 average value of 69.6 was located on the conversion line and a vertical dropped to intersect the correction line, thus obtaining a corrected value of 68.1 for R_1. This corrected R_1 value was used with the R_3 average value previously obtained to draw the line on the nomograph, *Fig.* 3. By this means, decarburization depth was determined to be 0.010 inch.

Though no more absolute than the visual or microhardness methods of determining decarburization depth, this method does offer consistent and nondestructive measurements, determined quickly by Rockwell operators rather than metallurgists.

REFERENCE SHEET

GRINDING space age MATERIALS

SPACE-AGE MATERIALS can be broadly classified as refractory hard materials and metals. The refractories include dense silicon carbide, dense high-purity alumina, the borides of zirconium and titanium, and flame-sprayed coatings. The metals include tungsten, molybdenum, zirconium, titanium and columbium (now called niobium).

Because of their hardness and sensitivity to heat, these materials must be ground to final size and finish. With grinding, it is possible to avoid stress concentrations that might lower fatigue limits.

Selection of wheels and cutting conditions is generally guided by the criteria used in grinding conventional materials. For fine finishes, fine-grit wheels, light stock removal, fast speeds and small crossfeeds are required. For heavy stock removal, coarse-grit wheels, heavy infeeds, slow speeds and heavy crossfeeds are used. In both cases, water-soluble emulsions make satisfactory coolants. (An exception: nitrite amine is used for zirconium and titanium.)

The wheel specifications shown in TABLE 1 and the grinding recommendations shown in TABLE 2 are approximate. Exact and final grinding conditions depend on the specific objectives of a grinding operation—whether it is to remove stock, generate a form or produce a finish. Conditions can be improved by trial and error as a job progresses until the optimum is reached.

Refractory hard materials can be ground on a practical basis to finishes of 40 microinch with diamond wheels and finished with silicon carbide wheels to around 5 microinches. Finer grit diamond wheels can bring the finish to 2-3 microinches. The thermal spray coatings—flame-sprayed alumina, flame-sprayed phenolic impregnated alumina and chrome-nickel-boron self-fluxing alloys—tend to peel off the parent roll if excessive heat or pressure is produced. Diamond wheels (resinoid bonds are used to minimize heat and pressure) remove stock rapidly and maintain accurate size. Silicon carbide vitrified wheels remove practically no stock but are able to generate high luster finishes. The finish obtained depends somewhat on the porosity of the coating.

The Space Age metals cover a wide range of grindability—from molybdenum which is easily abraded by ordinary methods to titanium, which has a grindability ratio of 0.7. Tungsten alloyed molybdenum is sensitive to heat and checks easily. It is best ground with a soft wheel, sharply dressed and provided with a copious supply of grinding fluid. The high-temperature, high-strength alloys such as A286, R235; MoTi and Armco PH 15-7 can be ground, using vitrified wheels, without burn, check or chatter. Pure tungsten tends to check easily. Wet grinding minimizes heat build-up and checking and is recommended.

From "Grinding of New Materials," by John A. Mueller*, presented at the Abrasives Seminar, May 1960. The Carborundum Co., Niagara Falls, N. Y.

*Senior member ASTME Buffalo chapter.

Table 1—Recommended Wheel Specifications for Grinding Space-Age Materials

Material Ground	Grinding Operation	Type Abrasive	Type Grain	Grit Size	Grit Grade	Type Structure	Type Bond
Silicon carbide	Centerless, rough	Diamond	---	100	N	---	Metal
	Centerless, finish	Silicon carbide	Regular	80	J-K	Close	Vitrified
	Surface, rough	Diamond	---	100	N	---	Metal
	Surface, finish	Silicon carbide	Regular	100-120	J-K	Close	Vitrified
High-purity dense alumina	Surface, finish	Diamond	---	120*	N	---	Metal
	Cylinder, finish	Silicon carbide	Regular	80-120	J-K	Close	Vitrified
Thermo-spray coatings	Roughing	Diamond	---	100	N	---	Resinoid
	Finishing	Silicon carbide	Regular	40-60	J	Close	Vitrified
Zirconium and titanium	Surface	Silicon carbide	Regular	46	H-J	Close	Vitrified
	Cylinder	Silicon carbide	Regular	60	J-K	Close	Vitrified
Columbium (niobium)	Cutoff	Aluminum Oxide	Regular	100	R	Normal	Rubber
	Surface	Aluminum Oxide	Semifriable	60	H-J	Open	Vitrified
Pure tungsten	Surface†	Silicon carbide	Semifriable	36	J	Close	Vitrified
High strength, temperature alloy	Cylinder	Aluminum Oxide	Semifriable	465	K-L	Open	Vitrified
	Surface	Aluminum Oxide	Semifriable	60	H-J	Open	Vitrified
Tungsten Alloyed Molybdenum	Surface	Aluminum Oxide	Semifriable	46-60	F-G	Open	Vitrified
	Form	Aluminum Oxide	Friable	100-120	I	Close	Vitrified
	Cylinder, rough‡	Silicon carbide	Friable	60	H	Open	Vitrified

*120 grit produced a 5-6 microinch finish, 500 grit produced a 2-3 microinch finish.
†The same specifications apply for centerless grinding, except K grade can also be used.
‡The same specifications apply for cylindrical finish grinding, except I grade can also be used.

Table 2—Recommended Conditions for Grinding Hard Space-Age Materials

Type of Material	Grinding Operation	Wheel Speed (fpm)	Work Speed (fpm)	Infeed (inch)	Wheel Dressing
Silicon carbide	Centerless, rough	5500-6500	80-100	0.0005-0.001	None
	Centerless, finish	5500-6500	150-200	0.0002	Medium
	Surface, rough	6000	35-50	0.001	None
	Surface, finish	6000	50	0.0002	Medium
High purity dense alumina	Cylinder, finish	5500-6500	100-150	0.0002	---
	Cylinder, rough	5500-6500	70-100	0.001-0.002	---
Thermo-spray coatings	Finish	5500-6500	100-150	0.0002	---
	Rough	5500-6500	80-100	0.0005-0.001	---
Zirconium and titanium	Surface	Conventional feeds and speeds, ½ normal wheel speed for light infeed			
	Cylinder	Conventional			
Columbium (niobium)	Cutoff	Conventional wet grinding			
	Surface	Conventional wet grinding			
Pure tungsten	Surface	Conventional wet grinding			
High-strength temperature alloy	Cylinder	Conventional			
	Surface	Conventional			
Tungsten alloyed molybdenum	Surface	5500-6500	60-80	0.001-0.002	Open
	Form	5500-6500	60-80	0.0005	Fine
	Cylinder, rough	5500-6500	80-100	0.001	Open
	Cylinder, finish	5500-6500	100-150	0.0005	Fine

Drilling Titanium

In the August Reference Sheet on drilling titanium, data given in TABLE 2 apply chiefly to chisel point drills. Greater effectiveness can be obtained using spiral point drills with the geometry listed (right). Cutting and feed recommendations are the same for both spiral and chisel points as listed in the August Reference Sheet.

Type of Operation	Point Angle (deg)	Relief Angle (deg)	Rake Angle (deg)
General and deep-hole drilling	118	9-10	0
Sheet drilling	180	9-10	0

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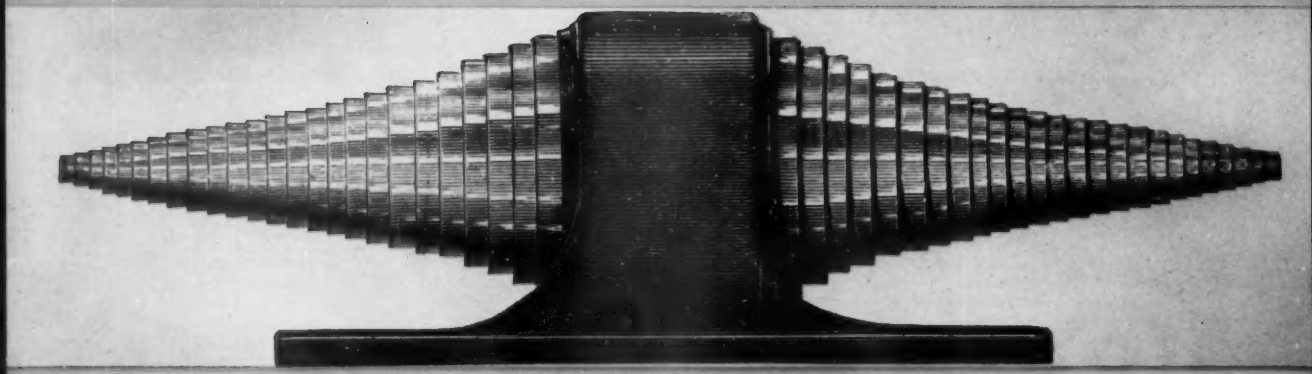

Do you have one of these? See "Hall of Tools," page 129.

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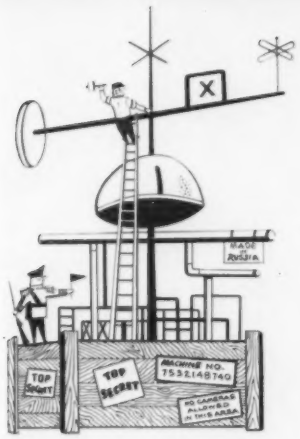


L. A. Forum to Discuss Red Industry

A KIND OF SUMMIT conference among men important to the maintenance of this country's industrial supremacy will be held on the campus of the University of California at Los Angeles this November. The Public Affairs Forum, scheduled for Tuesday, Nov. 15, during ASTME's Western Engineering Conference and Exhibition, will be devoted to a discussion of "The Race for Manufacturing Supremacy: an Evaluation of Manufacturing Progress in the Communist World."

Success of a similar forum on "The Engineer's Responsibility to His Community," held during the Society's April meeting in Detroit, prompted the scheduling of this second in a series of conferences on problems affecting the engineer.

An engineer keenly aware of these problems, both in this country and abroad, Dr. Harry B. Osborn, will moderate a panel of four experts. A past national president of ASTME, Osborn spends, as technical director of the Tocco Div. of the Ohio Crankshaft Corp., a good deal of his time studying and evaluating the international manufacturing scene.

The following panel members will lend their insight to the situation of Communist competition and its threat to Free World manufacturing: Henry Noebels, manager of application engineering, Scientific and Process Instrument Div., Beckman Instruments, Fullerton, Calif.; Robert Kudlich, director of computer research and development, AC Spark Plug Div. of General Motors, El Segundo, Calif.; Edward E. Tuttle, executive vice president, Essick Mfg. Co., Los Angeles; and Nevin L. Bean, staff engineer, Ford Motor Co., Livonia, Mich. Bean, a member of ASTME's Detroit chapter, has lectured widely on his experiences in Russia.

Accident Insurance Offered to Members

A comprehensive new accident insurance plan that will provide $10,000 accidental death and dismemberment protection for as little as $9 a year has been approved as an added member service by ASTME officers and directors. The accident coverage will supplement the popular income protection plan which has been offered to Society members for several years.

The accident insurance is offered only to members and their wives, at their option. ASTME will not participate directly in the program aside from sponsoring it, nor will it assume any cost or labor involved in servicing the group policy.

In announcing the new coverage, Executive Secretary Harry E. Conrad pointed out that members who now have comparable protection under individual policies can, by taking the group policy, realize enough savings to cover all or a substantial part of their Society dues.

Effective date of the insurance will be Oct. 15. Coinciding with this announcement, the plan will be explained at chapter meetings this month. Those interested can find details and an application blank in the advertising pages of this issue.

The plan is available to members regardless of age or health history, in amounts from $10,000 to $250,000. The annual rate for the basic AD&D plan is 90 cents per $1000. In addition to the death and dismemberment coverage, a member may select blanket medical expense coverage in amounts up to $10,000, at $12 for the first $1000 and $6 for each additional $1000. For those who desire it, income protection for accident in amounts from $25 to $250 may be added, at a premium rate of 85 cents per $5 benefit.

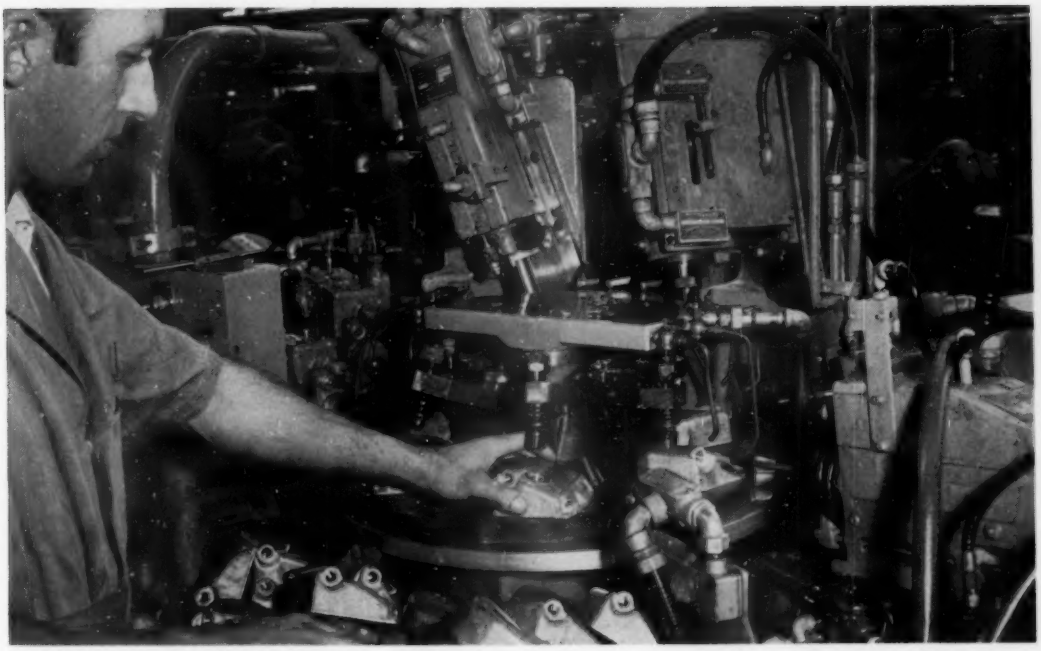
Conrad said that policy exclusions include loss resulting from suicide, bacterial infection, natural causes including medical or surgical treatment, war or any act of war and being in the armed forces of any country at war, hernia, or while acting as crew member of any aircraft. Members in the National Guard or Reserves are covered so long as the United States is not at war.

The policy is written through Bankers Life & Casualty Co., Chicago. The company has assets in excess of $150 million.

An aerial hitchhiker, the X-15, leaves its roost under the wing of an Air Force B-52 bomber after achieving the height of 38,000 feet. The Western Engineering Conference's host committee, realizing the importance of the tool and manufacturing engineer's role in the Space Age, has included the home of the X-15—North American Aviation, Inc.—on the plant tour list.

Ten Tours Slated for

Micro-Path, Inc., engaged exclusively in the design and production of automation for industry, is one of two plants set to be visited as part of the Numerical Control Techtour. Representative of the layout at Micro-Path is this view of the electrical assembly line and console assembly and test-out area.

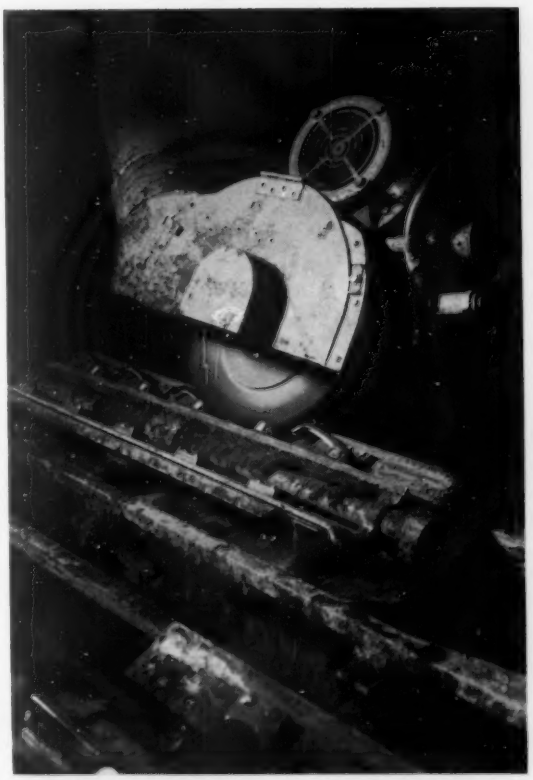


McCulloch Corp. will offer L. A. visitors an opportunity to watch a multiple-head indexing machine perform drilling, tapping, reaming, and counterboring at six different stations. The firm is noted for the manufacture of gasoline-powered chain saws, Scott outboard motors and other internal combustion engine products.

L. A. Meet

TEN PLANTS, all representative of the diversified industries that have settled in the hills and valleys of southern California, will be open to ASTME members attending the 1960 Western Engineering Conference and Exhibition this November. Industries ranging from aircraft to automation have attracted skilled workers from all over the nation, causing the population of the Los Angeles area to swell unbelievably. The L. A. Host Committee anticipates an additional swelling when Society members converge on the area come November.

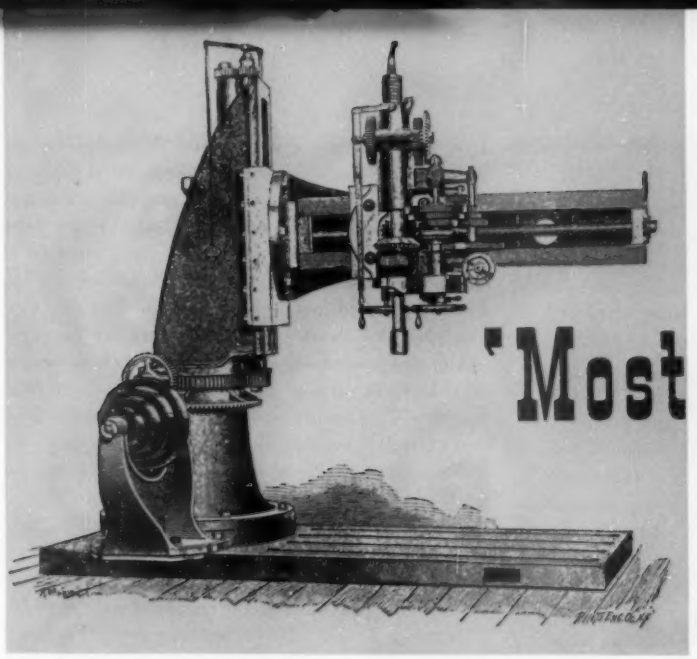
The ten plants scheduled for touring by the California visitors are: The Hufford Corp.; McCulloch Corp.; Crown Zellerbach Corp.; Douglas Aircraft Co., Inc.; the Long Beach Naval Shipyard; North American Aviation, Inc.; AiResearch Mfg. Co.; Kwikset Locks, Inc. (Powder Metallurgy Techtour); Micro-Path, Inc., and Mechanical Specialties (both part of the Numerical Control Techtour).



One of the two "Techtours" scheduled during the L.A. conference is a combination technical paper and plant tour dealing with powder metallurgy. The plant to be visited is Kwikset Locks, Inc. Typical of the things to be seen at Kwikset is the finishing of door handles and locks as shown above.

Looking like Gulliver being besieged by the Lilliputians, this giant DC-8 gets a going over from engineers and mechanics at the Douglas Aircraft Co., Inc. Douglas is one of the two airplane plants to be toured during the four-day Western Engineering Conference and Exhibition.

The largest floating crane in the world, this structure looms up in the harbor of the Long Beach Naval Shipyard, one of the spots scheduled to be toured by Society members in November. The crane was one of three captured from the Germans in 1945. The British lost theirs when it capsized in the English Channel. The crane captured by the Russians has not been seen since it crossed the border into Danzig.



'Most Wanted' List for Hall of Tools

Here's a radial drill of the 1870's, probably built by Wm. Sellers and Co., Philadelphia. This wood engraving is from the 1880 Census Report. Curator Ferguson is looking for such a drill with column height up to 14 ft to set the theme for the Smithsonian's new Hall of Tools.

By M. L. Stone, News Editor

AN ENGINEER WHO LOOKS only ahead is shortsighted, according to one who specializes in looking backward.

"Many people in the metalcutting world think that the most cutting remark they can make about a tool or technique is that it's a 'museum piece,'" says Eugene S. Ferguson, curator of the Division of Mechanical and Civil Engineering at the Smithsonian Institution, Washington. "They are wrong."

To Ferguson, those persons in the fast-moving manufacturing business who regard yesterday as obsolete, today as inadequate and tomorrow as the only fit object for thought, may very well be missing a bet.

"So-called museum pieces can provide the perceptive practicing engineer with insights and background that will enrich and enlarge his understanding of his own profession—and perhaps inspire him," he declares. "The tools of yesterday, properly displayed and interpreted, can give him enduring principles on which to base his thoughts for tomorrow."

Belying this philosophy, Ferguson is himself busy these days concentrating on the future—some time in 1962 or early 1963, when the Smithsonian's Hall of Tools will be opened.

The Hall of Tools will be one of 47 in the Institution's $28-million Museum of History and Technology, now abuilding in the shadow of the Washington Monument. The tool and manufacturing engineer, Ferguson contends, will have a stake in many of the halls — those telling their three-dimensional stories of textiles, light machinery, transportation and so on. But the Hall of Tools will be uniquely the expression of ASTME members' profession, concerned as it will be solely with the technics and artifacts of tool engineering.

Dominating the entrance will be a pre-1870 radial drill of Gargantuan—but pleasing—proportions. Such a drill, incidentally, with a column height to 14 ft or so, is No. 1 on Ferguson's "most wanted" list of equipment to fill his 5000 sq ft of exhibit space.

Urges Engineers To Search Attics

Ferguson hopes to fill his wanted list with the help of ASTME members and other tool and manufacturing engineers, machine tool builders, machinery dealers and shop owners who are in a position to recognize the possible significance of tools that are in attics and in sheds, that have somehow escaped the attention of broom-wielders and junk dealers.

Besides the theme-setting radial drill, he is on the lookout for:

- Blacksmith's drill, post mounted, hand or belt driven, of pre-Civil War pattern.
- Richards' Standard Step Gauge (a master gage for calibration of snap gages, circa 1890, is pictured on the cover of this News Section).
- R. Hoe bench micrometer, 1860.
- Caliper, plug and limit gages of the 19th century.
- Grinding wheels, including leather emery wheels before 1890.
- Smith's plane. Similar to carpenter's plane, except blade

is replaced by a planer tool, which is held vertically in the plane body. Used in 1830's and probably later.

- Fellows' Gear Shaper, before 1900.
- Early lathe tool dynamometer.
- Hartness Screw Thread Comparator, before 1920. Looks like the familiar magic lantern, located in line with workholding fixture on a pedestal. Wall screen was used.
- Brown & Sharpe Pocket Sheet Metal Gage, 1867.
- Self-centering lathe chuck, very early. Horton's patent was in 1855.

He wants the radial drill to set the Hall of Tools theme because the machine depicts the four basic elements of any machine tool: the cutting element or tool, the workholder, the rigid connector between the tool and the work, and the means for applying power to move the cutting element in controlled relation to the work.

Earliest of these imposing machine tools (a wood engraving of one of them is reproduced with this article) were developed in England around 1841. Radial drills made their U.S. appearance about the time of the Civil War, and were in general use by the 1870's, Ferguson says.

Alongside the big drill, and related to it by shape and function, will be a full-size sculptured figure of a kneeling aborigine. The man will be using a bow drill on a workpiece clamped between his knees.

Nearby an exhibit of "Machines That Make Machines" will show the basic operations—drilling and boring, planing, milling, turning and grinding—that are performed by general-purpose tools.

Don Berkebile, exhibits craftsman at the Smithsonian, slicks up a No. 1 Brown & Sharpe universal milling machine for exhibition while Eugene Ferguson, curator of tools, looks on. The machine, serial No. 485, was built in 1882.

One set of displays will depict the trend toward automation—including the development of program control from the 16th century tracing lathe through the turret lathe and screw machine to the tape-controlled miller. Other showcases will explain to the public, and to the engineer, how science has been applied to machining; how the idea of interchangeability developed; the history of measurement; new machining developments such as ceramics; and, in actual operation, a pre-Civil War machine shop showing many significant tools from that period of incubation of modern concepts.

Ferguson says he is also interested in items for wall decoration in the shop—calendars of 1855 or earlier, political notices, vintage catalogs and brochures—"but nothing gaudy."

An elaborate epic of hand tool development should also provide a deeper understanding of his profession to the discerning engineer, Ferguson believes. For example, the curator related, it came as a distinct surprise to him recently to discover the striking similarity between a Roman plane of 200 A.D. and a Stanley No. 5 jack plane. The hand tool display should point up, he added, the idea that invention is a culmination, rather than a beginning.

Basically the Hall of Tools will explain what tools are, what they do, and why; how they evolved; and how they have enormously increased the productivity of labor, thus making possible America's high material standard of living.

"The underlying and unifying theme of all exhibits having to do with productivity will be the frequently unrecognized fact that people—specifically, tool and manufacturing engineers—are responsible for the development of the machines and techniques that make possible modern manufacturing methods," Ferguson stated.

Better Than Reading a Book

Why not read a book rather than make a trip to a museum?

Ferguson's reply: "When one of your foremen comes into your office with a problem from the shop or the production line, you reach for your hat and say, 'Let's go have a look at it.' When we can see and study a three-dimensional object, we can appreciate features that no amount of text or picture can accurately convey."

Ferguson accepted the Smithsonian assignment two years ago after a dozen years of teaching mechanical engineering at Iowa State College. He has roamed the country looking for significant artifacts for the new hall, and he has studied similar collections in the great museums of Europe.

He firmly believes that the tools of yesterday, properly displayed and sympathetically studied, will help engender better tools for tomorrow.

Chapters Get Behind Apprentice Program

By I. Harry Hyman
State Supervisor
Bureau of Apprenticeship and Training
U. S. Dept. of Labor
Hartford, Conn.

IT IS A RARE COLUMN in the help wanted sections of our metropolitan dailies that does not contain at least one ad reading:

WANTED—First-class Toolmakers!

This recurring plea for trained talent raises the following questions—questions whose answers are the direct or indirect concern of every tool and manufacturing engineer:

Who will make the jigs, fixtures, dies, prototypes and machine tools in the 1960's?

Have we trained an adequate number of young men in recent decades to replace the metalworking craftsmen who leave this work force every day because of retirement, death, illness, promotions?

Are our programs of training in the shops and schools good enough to develop men who can build the increasingly precise and complex tooling which will be designed in the new decade?

Society Members Respond

If metalworking people, and especially the tool and manufacturing engineers among them, do not have positive answers for these questions, they should realistically do something about it.

That is exactly what the ASTME's chapters in Connecticut did.

When the questions were posed to a number of Society members in that state, they invariably agreed that

- The metalworking industry is critically short of skilled craftsmen
- The situation is getting progressively worse
- Training, generally speaking, is inadequate both in numbers and quality
- Tool cost, delivery and quality are seriously affected by the shortage of craftsmen.

To focus attention on these problems, Connecticut ASTME members joined other interested organizations in sponsoring the state's fourth annual Metalworking Trades Apprentice Competition this year. Others backing the program were chapters of the National Tool & Die Manufacturers Association and the Manufacturers' Association of Connecticut in cooperation with the Department of Labor's Bureau of Apprenticeship and Training; and the state's Departments of Education and Labor.

Thirty companies entered a total of 66 fourth-year apprentices in the competition. Among the participants were Pratt & Whitney, Chandler-Evans, the Royal Typewriter Co., The Fafnir Bearing Co.,

Ralph Howes (right), one of the 25 finalists in Connecticut's Metal-Working Trades Apprentice Competition which ASTME chapters helped sponsor, receives a *Tool Engineers Handbook* from Competition Chairman John D. Dewhurst at the recent honor awards dinner. Dewhurst, a member of Hartford Chapter 7, is president and treasurer of the Arrow Tool Co., Wethersfield, Conn.; Howes works for him.

Pitney-Bowes, Inc., Arrow-Hart & Hegeman Co., Mattatuck Mfg. Co., Cottrell Co., Electric Boat Div. of General Dynamics, The Bullard Co., New Departure Div. of General Motors, Sargent & Co., American Hardware Corp., and Stanley Works, as well as several of the outstanding contract tool shops.

25 Selected as Finalists

The contest included a six-hour written examination, with 25 apprentices who scored highest on this examination selected as finalists. Each finalist was given a practical examination at his shop by a team of three judges with long experience in the metalworking industry.

Approximately 150 persons, including representatives of industry, the sponsoring organizations and apprentices, attended dinner to honor the six apprentices who were judged outstanding. The apprentices and the companies in which they were learning their trade got special awards. All finalists were given *Tool Engineers Handbooks* as prizes.

At the awards dinner, John D. Dewhurst, chairman of the competition committee, declared that "national projections show at least 25 percent more metalworking craftsmen will be needed by 1970. And the ratio of metalworking apprentices to journeymen in Connecticut is below the national average.

"Industry needs to do more training but, equally important, it has to do a selection and training job which will provide the quality of craftsmen who can do increasingly complex work demanded by our advancing technology."

Sponsors believe the successful Connecticut competitions can be an effective tool in meeting the problem cited by Dewhurst. Such competitions give recognition to outstanding apprentices and to companies conducting effective training programs; alert industry to the need for training to meet present skill shortages and projected needs; improve the quality of training by giving recognition to journeymen and supervisors who, in daily shop routine, do outstanding work in helping apprentices acquire skills; improve the quality of training by stimulating apprentices into making the intensive learning effort needed for qualification as finalists in the annual competitions; bring young men with growth potential to management's notice; acquaint potential candidates for apprenticeship with training opportunities in metalworking; and, finally, bring to the attention of young men and guidance instructors in secondary schools the basic preparation in math and science needed for success in apprenticeship.

Valuable Partner of the Engineer

ASTME members in Connecticut took a leading role in sponsoring the competition because they believe sound apprenticeship is the best means of developing the skills needed to convert blueprints into functioning tools. They know the toolmaker is a valuable partner of the manufacturing engineer.

Welding Research Contract Is Placed

A $2000 WELDING RESEARCH contract has been placed with Syracuse University by the Society's Research Fund Committee. The project, entitled "The Study of Distortion and Residual Stress Effects in Welding, Using Strain Gage Dynamometry Techniques," is in cooperation with the Welding Research Council of the American Welding Society.

ASTME's funds supplement a 1959 grant of $1250 from AWS, which Syracuse had previously described as "too small to give full support" to the research.

Work was scheduled to start this last month with completion by June, 1961.

Syracuse researchers have for some time been developing methods for using strain gages to measure forces in ways hitherto impossible. One of these developments is measurement of residual stresses in weldments. According to Chairman Bert H. Norem of Syracuse's Department of Industrial Engineering, one of the possibilities that is most intriguing about the new instrumentation is that of studying the machining effects on residual stresses in a plate.

"For example, two pieces of steel could be welded together and the stress pattern measured," Norem said. "Then, without releasing the piece, we could machine away parts of the weld and measure the changes. In addition to machining, the effect of other treatments—such as shotblasting—could be studied.

"It seems to me that the tool and manufacturing engineer should be as interested in this research as the welding engineer."

The Research Fund Committee, under the chairmanship of Howard C. McMillen, agreed. It earmarked for the research the sum of $1926.79 which had been donated to the Society, and from its own funds rounded off the figure to $2000. Research Director Leslie F. Fletcher then signed the contract with Syracuse, which has already been working with ASTME on a research project on metal stamping.

Chapter Team Puts

Go-Kart Before the Horse

LONG ISLAND—Because they believe in progress, tool and manufacturing engineers have always—in one sense—put the cart before the horse.

Now a team of Chapter 88 members has supplanted the cart with a Go-Kart, one of those low-slung, gasoline-powered soapboxes that have recently found such a market.

Comprising the team are Chairman Vince Morgan and members of his Plant Layout Committee, who are already moving toward results in a novel engineering project which they have dubbed "Hobbymobile." They are engineering the selected product from the market research analysis to the fabrication of the prototype. From the experience the participating "manufacturers" expect to gain added background and experience in manufacturing phases to which they have not heretofore been exposed.

Project Hobbymobile's over-all goal is to answer the question, "What is required to manufacture a profitable product in a competitive market, starting with nothing except capital?"

"Emphasis will be placed on an efficient manufacturing plan and an economical flow of the product through an effectively organized plant," Morgan said. "Check lists, systems and procedures will be written up for the design, purchasing, planning, tooling and plant layout. Organization, flow and plant layout charts, as well as facilities, equipment and tooling surveys, will be constructed or conducted as needed.

"Papers on material handling, time standard and market research will be submitted. Standards for machine, bench and assembly work areas will be set up and manpower-space relationships will be derived."

The design should be fairly well firmed up by the time chapter activities resume this month, Morgan reported. Operation sheet writers are at work on the detail parts. The wheels and engine have already been acquired.

Here are some problems encountered in the early stages of Hobbymobile, according to Morgan: "The first problem was one of product selection. We must have gone through a hundred suggestions before deciding.... We had to select a product that wasn't too complex with regard to manufacturing operation and the equipment required for manufacture, and then again it couldn't be too simple. We felt that we achieved the happy medium in our selection.

"We then collected literature on available Go-Karts and their prices to help us in our product design. We also set a production rate figure and a target selling price. We became bogged down in the design when we tried to incorporate the most desirable features of the various models, and our project slowed down considerably. We then decided to select an existing cart of good design and work around it, making changes as we saw fit. At least in this way we could get out our detail part drawings to the operation sheet writers, tool planners and equipment selection group. Preliminary plans could also be made regarding size of plant and manufacturing operations."

By now these problems are in the past, and it's all go-go-go around Long Island. Fabrication should be started shortly.

Chips and Chatter

Col. Leslie S. Fletcher (left), ASTME research director, and Prof. John E. Biegel of Syracuse University examine the press setup which produced 1,059,408 test slugs at the university laboratory for the Society's punchability research. The project is seeking to determine if there is a method for measuring the punchability of electrical steels. In a progress report on the research during a recent campus meeting of the ASTME Metal Stamping Project subcommittee, Biegel estimated that another 500,000 slugs would be made before the university's contract with the ASTME Research Fund is completed some time this month.

Displaying one of 1000 reprints of an ASTME Annual Meeting paper which he ordered is the chairman of the President's Committee on Employment of the Physically Handicapped, Maj. Gen. Melvin J. Maas, USMCR Ret. The general was favorably impressed by the paper on "Tooling for the Handicapped," which was presented by Editor John W. Greve of THE TOOL AND MANUFACTURING ENGINEER during a special medical-engineering session at Detroit last spring. Besides distributing copies to his organization's state committees and other influential people in the field, Maas is also republishing the paper in *Performance*, the official magazine of the President's Committee. Maas said the article, which challenges engineers to apply their know-how to the economically vital problem of handicapped workers, would appreciably abet his committee's efforts to further the observance of National Employ the Physically Handicapped Week, Oct. 2-8. The committee, authorized by Act of Congress, attempts to enlist the cooperation of public and private groups in a year-round program.

Incidentally, readers who collect stamps can get this new blue one showing a man operating a drill press from a wheel chair. The stamp was released Aug. 28 to coincide with the first World Congress ever held in the United States by the International Society for the Welfare of Cripples. In publicizing the stamp, the President's Committee on Employment of the Physically Handicapped pointed out that such workers can be particularly industrious, efficient and grateful employees, with below-average absenteeism and accident records. First-day cancellations of the stamp can be obtained from the Postmaster, New York 1.

Who is the oldest active member of ASTME? The most obvious candidate for that distinction is an 87-year-old stalwart of ROCHESTER Chapter 16. Charles Codd, a charter member of the 23-year-old chapter, its second chairman and its chapter historian, comes to meetings in a wheel chair. And he sees to it that his son George, a production engineer at Kodak's Hawkeye works, also attends. . . .

Charlie Codd retired in 1947 after 47 years with Ritter Dental, where he was master mechanic. "They wanted me to stay on till I had been there 50 years," Codd said, "but enough's enough."

Born in 1873 in England, Codd came to America

15 years later, managed to find an English girl to marry just before the century turned. Meanwhile, he pedaled his way to professional status as a bicycle racer. He also began pedaling his way toward the top of his trade as a toolmaker. He served his apprenticeship at the Buffalo Steam Pump Co.; went "west" to Detroit for a couple of years with the Leland Falkner Co.; worked in development and toolmaking at bicycle manufacturing firms back in New York, where he developed the first ball-bearing bicycle wheel. After his marriage he settled down for his half-century at Ritter, a dental equipment company. Codd joined the Society in 1937 when Chapter 16 got its start. From his chairmanship in 1939 until his retirement in 1947 he served on the chapter executive committee. . . .

Another elder statesman of whom Rochester chapter is proud is 75-year-old William R. Gordon, who has the bearing of a senator and the know-how of a man who worked his way to chief tool engineer of the Eastman Kodak camera works before his retirement. Canadian-born, Gordon has had a long and colorful career as a tooling expert. During his various associations with pioneer automotive and truck companies, he was the first to develop an engine with integral transmission. He also worked in executive capacities in typewriter, oil burner, generator and textile machinery plants before joining Eastman Kodak. At Eastman, which he entered from the "front door," Gordon took charge of tooling, installed an 18-man design department, standardized a toolroom where standardization was needed (trimming 28 brands of carbon steel to three, for example).

Gordon joined the Society in 1939 and became Rochester's chairman ten years later. Since his retirement from Eastman a few years ago, he has built up a satisfying second-story business as a watchmaker, with certifications from the Horological Institute of America and the Watchmakers' Guild. He has the time of his life, he says, restoring antique clocks and watches.

Another cause for pride is a son, Robert B. Gordon, who is a Ph. D. graduate of M.I.T. in physical metallurgy and is now director of materials at Rocketdyne on the West Coast. . . .

QUOTE OF THE MONTH: "Too soon olt and too late schmart. . . . It seems we now have a great deal more knowledge to teach than we have time to teach it. Graphics (engineering drawing) is a language and obviously must be included somewhere along the line or communication is going to fail right where it is needed most. I am inclined to agree that this is a subject that can be moved up earlier in the education cycle."—Byron McPherson, chairman of DENVER Chapter 77, at the conclusion of the Summer Conference on Graphics at the University of Colorado.

In motorcycling regalia after a 460-mile trip from their West Covina, Calif., home to attend a San Francisco meeting of the California Council of ASTME chapters are Chairman Jack D. Bailey of SAN GABRIEL VALLEY Chapter 95 and his passenger-wife Marietta. The ride through cold mountains and hot desert took 10 hours. Bailey says they've enjoyed the motorcycle hobby as a couple for the past 20 years and hope to for another 20. "Although I have been hurt a few times while riding solo, as a tandem operation with my wife the only thing that was ever mussed up was her hairdo," he reported. Mrs. Bailey doesn't drive, but her passenger participation in balancing is a help for safe riding. Bailey added. He defends motorcycling as a clean, active and challenging sport which has gained a risky reputation not because of the machine but because of some operators. And Bailey adds that he and his wife have two children, a college boy of 18 and a high school daughter of 16, "just to indicate that we are an average family." Bailey operates Bailey Tool & Die Design in West Covina.

Members in the News

James W. Dopp

At the recent 74th annual meeting of the Engineering Institute of Canada, held at Winnipeg, W. A. DAWSON, professional engineer and assistant sales manager of Brown Boggs Foundry and Machine Co., Ltd., Hamilton, Ont., was elected to Council representing the Hamilton Branch. By virtue of this position, he finds himself chairman of the special committee on professional development programs. Dawson is a member of ASTME's National Education Committee.

LaPointe Machine Co. has announced the appointment of JAMES W. DOPP, Boston member, as vice president. Dopp will continue to serve as sales manager, directing the distribution of machine tools through the LaPointe sales force and selected distributors throughout the country.

EMMETT A. TIMM, member of Rockford chapter, recently appointed general manager of the Hoefer Mfg. Co. of Freeport, Ill., has now been elected vice president. Timm has been associated with the company since 1937, serving as chief engineer and active head of the engineering department.

The newly organized Pranell Machine Works, Philadelphia, has named THOMAS C. PRATT, Trenton Delaware, president. Pratt's career in the steel industry began at Jones & Laughlin Co. as a metallurgical inspector and millwright, in 1938. He also served 7½ years as superintendent of shops at U. S. Steel Corp. Fairless Works.

The ESBEC Corp., maker of barrel finishing equipment, has appointed THOMAS L. GRIFFIN regional engineer in the Worcester, Mass., and southern New Hampshire area. He is in Little Rhody Chapter. Griffin was manufacturing engineer for the Brown & Sharpe Mfg. Co. for 11 years and for two years he served as sales engineer for Providence Mill Supply Co. . . . LAURENCE D. GILLANE, Milwaukee chapter, has been appointed sales supervisor for metropolitan New York, New Jersey, Delaware and eastern Pennsylvania for Butterworth Div., Union Twist Drill Co. Gillane has had ten years of experience in the machine and metal-cutting tool field . . . . ERNEST JOY LANE of Tri-Cities chapter has been named by The Carpenter Steel Co. as regional metallurgist to handle technical service problems in the midwest. Lane has been a Carpenter salesman for four years and prior to his association with that company was with Ford Motor Co. and Studebaker-Packard . . . . EDWARD E. HALL, Erie chapter, has been promoted to assistant general sales manager for Universal-Cyclops Steel Corp. Prior to this appointment, Hall was manager of technical services and had also served as chief metallurgist of the company's Titusville, Pa., plant.

J. W. ARNOLD, Columbus chapter, has been appointed president and general manager of the Parsons Company, a division of Koehring Co., Milwaukee. The Newton, Iowa, firm manufactures trenching machines. Arnold was vice president in charge of manufacturing for the Hydraulic Press Mfg. Co. (another Koehring division) for five years before coming to Parsons in April of this year. Prior to that, he was general manager of Erie Engine and Mfg. Co. for four years. He also worked for Clark Equipment, Ford Motor Co. and Cadillac Div. of General Motors.

Emmett A. Timm

J. W. Arnold

ROCHESTER, N. Y.—A "Regional Leadership Conference" brought representatives of nine upstate New York chapters to Rochester recently. In this photographic montage, Chairman Van Buren Hansford of Rochester is seen bottom center, and Conference Chairman Franklin V. Brook, Rochester professional development chairman, is standing left center. Among results of the meeting was appointment of First Vice Chairman B. Ripin of Hendrick Hudson to serve as a regional clearing house for speakers. Other participating chapters: Buffalo-Niagara, Binghamton, Chautauqua-Warren, Elmira, Ithaca, Mohawk Valley and Bradford-Olean. The chapters also agreed to exchange bulletins.

—O. E. Hosford

chapter news

Piedmont Chapter Leader, Al Moosbrugger, Dies

GREENSBORO, N. C.—Albert Moosbrugger, one of the founders of Piedmont Chapter 82, died of cancer Aug. 23 at the age of 49. He lived in Winston-Salem and was department chief, industrial security department, at the Western Electric Co. there.

Moosbrugger joined the Society in 1942, at Kansas City, while he was a tool engineer at Aircraft and Accessories Corp. He transferred to the Dayton chapter in 1943 and to the Northern New Jersey chapter in 1945. In 1949 he joined with a small group in North Carolina to organize Piedmont. He served as the chapter chairman in 1951-52.

At the national level Moosbrugger served on the professional Development, Membership and Public Relations committees. A community leader, he conducted a ten-week course in human relations for the Winston-Salem Chamber of Commerce and had been a divisional chairman for the city's United Fund drive for the past four years.

Mexico Members Study Processes at GM Plant

MEXICO CITY—During a recent tour of the General Motors plant here, members of Mexico City Chapter 166 noted that the facility uses a high percentage of Mexican raw materials for the manufacture of their products.

The visitors saw the accumulator, spring, refrigerator, foundry, machine shop, pickup body, and plastics divisions of the plant. Of special in-

terest was the automatic process of tempering springs.

Among chapter guests was Harry Betts, chairman of Houston Chapter 29.

The program was arranged by F. Lamicq, program chairman. —*Victor M. Ramos*

Chapter 37 Expands Its Bulletin Program

INDIANAPOLIS—To stimulate reader interest and promote more active participation by the membership, Indianapolis chapter is expanding its monthly bulletin to 28 pages.

One of the new features will be a contributory section entitled "Nuggets from 37," which chapter officers unblushingly admit is a fairly direct steal from the popular "Gadgets" section in THE TOOL AND MANUFACTURING ENGINEER.

Another projected feature will be a series of ten consecutive articles that will advise the chapter membership on what books to read and what subjects to freshen up on in order to take and pass the examinations for professional registration under the laws of the state of Indiana. —*James J. Denney*

Chapter 106 Takes Part In Arizona Career Night

TUCSON, Ariz.—Tucson Chapter 106 provided engineers to serve as group discussion leaders during the second annual Career Conference sponsored by the Arizona Council of Engineering and Scientific Associations. The program acquaints high school students of the state with opportunities in the various fields of engineering.

ASTME members were among over 200 engineers representing 18 chapters from 13 different societies who participated in the two-session Career Night. The first session was held at Arizona State in Tempe Aug. 31; the second session, in which Chapter 106 participated, was held at the University of Arizona Sept. 6. —*G. H. Moritz*

special events

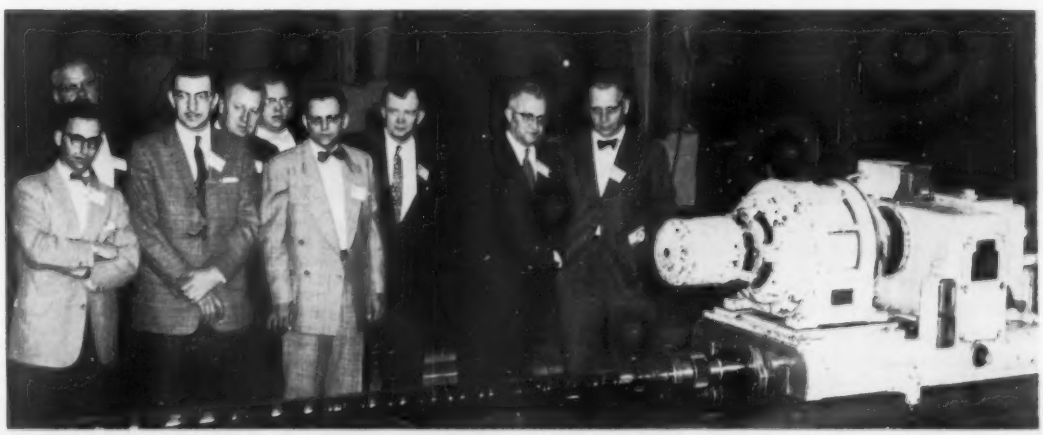
Wisconsin Council of Chapters' First On-Campus Conference	Oct. 29, 1960	Marquette University Milwaukee, Wisconsin
ASTME Semiannual Meeting	Nov. 14-18, 1960	Ambassador Hotel Los Angeles, Calif.
ASTME Western Tool Show	Nov. 14-18, 1960	Memorial Sports Arena Los Angeles, Calif.
ASTME 29th Annual Meeting	May 20-26, 1961	Statler Hilton Hotel, New York City
ASTME 1961 Tool Show	May 22-26, 1961	New York Coliseum, New York City

Granite State Member Dies

LACONIA, N. H.—Richard W. Hatch, charter member of Granite State chapter, died at the age of 43. Hatch was employed for 24 years as assistant supervisor of production engineering and drafting for Scott and Williams, Inc. He served his chapter as professional engineering committee chairman in 1955 and as standards committee chairman in 1957.

Hartford Plans Conference

HARTFORD, Conn.—Chairman Howard A. Wheeler has announced that Chapter 7 will stage its first on-campus conference on Dec. 8. The session will be held at the University of Hartford.



CHICAGO—Explaining a honing operation to a small group of the more than 80 Chicago chapter members who recently toured Flick-Reedy Corp., is Richard Morgan, chief production engineer. —*Jack C. Foster*

WENTWORTH INSTITUTE—Student Chapter 7 recently held a breakfast meeting which was attended by officials of the school and guests from the local ASTME senior chapter, Boston. Shown here following the installation of new officers are (seated, left to right) David Whittemore, second vice chairman of Boston chapter; Raymond Messier, newly installed student chapter chairman; Sherman Smith, outgoing chairman; and Wentworth's president, H. Russell Beatty. Standing are Roger Ames, faculty adviser; John Hartnett, treasurer; James Curran, secretary; Lawrence Beebe, first vice chairman; and Francis Pearsall, second vice chairman. Wentworth chapter has 92 members. ***—Sherman Smith***

MILWAUKEE—Receiving their $500 scholarship awards from Chairman Ralph Perlewitz are Dennis J. Trendel and Dennis E. Whitney, both graduates of Boys Trade and Technical High School in Milwaukee. The boys are using the scholarships to study mechanical engineering at the University of Wisconsin. At left is Edward Olson, head of the trade school drafting department. ***—Edmund Murphy***

MID-HUDSON—A scholarship grant of $250 for a needy engineering student has been instituted at Dutchess Community College in the name of Chapter 74. James F. Hall, president of the school, is shown here accepting the grant from Vincent Cavalieri, chairman of the Mid-Hudson chapter.—*E. R. Long*

RACINE—The "Mystery of Die Casting" was revealed to the Chapter 2 membership by Heinz Wernecke, chief design engineer at Kiekhaefer Corp., at the monthly technical meeting. On Oct. 21 the Racine chapter will observe its 25th anniversary with a special program. —*Paul R. Tiles*

UNIVERSITY OF KANSAS—ASTME Education Director Gilbert Seeley (second from right) talks with his hosts following a spring meeting of Student Chapter 3. Listening to Seeley, who spoke to the group on the Society's future educational plans, are (left to right) Jerry Stracke, chairman; Professor Howard Rust, faculty adviser; and Professor Paul C. Hausman, co-adviser. —*Charles Bradley*

MOHAWK VALLEY TECHNICAL INSTITUTE—For the third year in a row a student from Chapter 10 has been the recipient of one of ASTME's annual education awards. This year at a meeting of senior Chapter 78, Gerry Albertson (second from right) received the $400 scholarship and the congratulations of (from left) President A. V. Payne of the Institute, Chairman Don McKay of Mohawk Valley chapter, and B. G. Davis, head of MVTI's mechanical technology department. ***—James Fayette***

WINDSOR—A meeting of Chapter 55 brought together (left to right) Peter Hedgewick, president of the International Tool Co.; Dr. E. J. Storfer, staff engineer at Chrysler Corp. and guest speaker; and F. D. Rail, chapter chairman. Storfer's explanation of "Tooling in Plastics" was followed by the presentation of Windsor's service award to Jim Challoner for his work in inaugurating the first Canadian student chapter at Western Ontario Institute of Technology. ***—Steve Hazen***

LONG ISLAND—Chapter 88's June meeting was highlighted by the presentation of awards to the top three winners of the Third Annual High School Tool Design contest. The winners pictured here are (left to right) Peter LiCausi, first place; Herbert Schiller, second place; and Robert Kenny, third place. Thirteen boys and one girl won recognition for their participation in the contest. George W. McLellan of the Corning Glass Works spoke to the crowd of 150 about glass as an engineering material.—*Henry MacDonald*

Reports in Brief . . .

Midwest

A talk covering the present status of American tool industry as compared with that of Western Europe and Russia was the highlight of a recent meeting of the CINCINNATI chapter. The speaker, Ralph J. Kraut, president of Giddings & Lewis Machine Tool Co., urged faster tax write-off policies on U. S.-built tools to combat foreign competition. George W. Goodwin, past president of ASTME, was also a guest at the affair. . . . One hundred sixty senior high school students interested in engineering as a profession were invited to the annual student guidance program recently sponsored by the FOND DU LAC chapter. The young men toured the Manitowoc Engineering Corp. and Manitowoc Shipbuilding plant. They inspected a new ore carrier, the *Edward L. Ryerson*, which is nearing completion in the shipbuilding yards there and which is the largest such vessel on the Great Lakes. The inspection tour was followed by dinner and a talk by Arthur Zuehlke, vice president and manager, Marine Div. of the shipbuilding company. Zuehlke emphasized the importance of engineering in this modern mechanical age and described the engineering problems in connection with the design of such a huge vessel. William Warren, Fond du Lac chairman, explained to the students the function and purpose of the guidance program.

West Coast

One hundred four members of LONG BEACH chapter on Aug. 10 and 60 members of LOS ANGELES chapter on Aug. 11 heard W. W. Wishart, chief metallurgist of Verson Allsteel Press Co., speak on "Impact Machining." He explained what cold extrusion is and how it moves metal, and the designing of forward and backward extrusion dies. The increase in attendance at Long Beach was due to the change from the former inadequate meeting place to Lakewood Country Club.

South

"Gun Drilling Versus Twist Drilling" was the topic up for discussion at CHATTANOOGA's August meeting. Howard Noll of the Standard Tool Co., Cleveland, Ohio, addressed the group at the University of Chattanooga's Hunter Hall.

Northeast

The MID-PENNSYLVANIA chapter heard a discussion of "Heat Treating" by Carl A. Mayer of the tool and alloy division of The Carpenter Steel Co. . . . "Rotary Swaging" was the topic presented by Lloyd A. Whiting, chief engineer of the Torrington Co. at a meeting of BOSTON chapter. The speaker explained the low cost of rotary swaging was due to the simplicity of the swaging dies and economy in tooling. At this same meeting, the chapter acted as host to the Franklin Institute student chapter whose new officers were sworn in by Boston's immediate Past Chairman Nick Juliani. . . . At the recent technical meeting of NORTHWESTERN PENNSYLVANIA chapter, Vincent E. Lysaght, general sales manager for Wilson Mechanical Instrument Div., American Chain & Cable Co., explained the development and importance of "Hardness Testing and Measurement." Lysaght defined hardness testing as "the resistance" of a material to indentation,

as compared to resistances offered by other materials. In making an indentation hardness test, explained the speaker, the tester's indenter, which is forced into the material, comes to rest when the indenting load is exactly supported by whatever it is that resists further indentation. The cold-worked and crushed portion is what metallurgists accept as the index of hardness. Lysaght emphasized the critical requirements for the test of thin sheet metals and cylindrical parts, calling attention to the need for proper support of the workpiece to prevent distortion or harm to the indenter. Concluding his talk, he gave considerable attention to the techniques employed and various applications of microhardness testers, such as Brinell, Rockwell, Rockwell Superficial, 136-deg Diamond Pyramid, and the Scleroscope units.

Australia

At the July meeting of SYDNEY Chapter 144 Don MacGregor, works manager of Australia Consolidated Industries Engineering Pty., Ltd., spoke on glass manufacture from the Egyptian and Roman eras and the days of the world-renowned Venetian glass, to modern manufacturing techniques. His talk covered furnacing and mold design.

Ceramics' Role in Space Age Revealed at Long Beach

LONG BEACH—The ceramics industry, long characterized by a myriad of commercial products which have changed little in decades, is finding tools to satisfy the startling demands of the fast-moving aviation and missile industries. James D. Welterlen, research engineer and project leader at Gladding, McBean & Co., slanted his talk before the Chapter 84 membership toward these new ceramic products receiving wide acceptance in this country's aeronautical and space programs.

Welterlen related that ceramists have been utilizing new-found scientific skills and materials to meet the challenge presented by aeronautical designers who realize the ability of ceramic products to withstand extremes of temperature and abrasion. The result of this accelerated program, the speaker said, has been a new order of ceramics which bear little resemblance to their clay counterparts. These new materials possess purities above 90 percent, near theoretical densities, and have created new processing techniques which no longer rely on the natural plasticity of clay materials, but on the addition of organics. The most recent advances have been noticed in the aviation and electronics fields.

The popularity being enjoyed by ceramics in aeronautics, Welterlen continued, has been prompted by the need for high temperature and oxidation resistance. Melting points of ceramic range from 1900 to 2700 C. Of further importance is the excellent resistance to rain erosion which some of these materials exhibit. Exposure of aluminum oxide to Mach 2 rain field has only cleaned the surface of the ceramic, but virtually destroyed the supporting metal fixtures. The high modulus of elasticity of these materials can be put to good use in structural components reducing flutter.

Turning to the electronic field, Welterlen said that ceramic materials of the titanate group are utilized to produce a wide range of dielectric constants and temperature coefficients in components. Magnetic ferrites serve in memory devices and cores at elevated temperatures. Ceramic vacuum tubes capable of operating in high ambient temperatures and under severe vibration and shock conditions have also been introduced, the speaker said. It has been found that these ceramics possess good resistance to nuclear radiation and are proposed for electronic, structural and functional components in aircraft propulsion systems, Welterlen concluded.

—Paul J. Bodnar

positions wanted

SALES MANAGER—Widely known in the tooling and industrial supply field. In early forties; ten years' national sales management for large tool firm. Will relocate. Write to Classified Ads for resume. Dept. 187, 10700 Puritan Ave., Detroit, Mich.

ESTABLISHED MANUFACTURERS' AGENT—large, fast-growing area in south central United States can satisfactorily represent one or two more perishable tool items. Have good entree to most major manufacturers. Our sales engineers have practical machine shop experience. We would welcome the opportunity to exchange references. Write to Classified Ads, Dept. 188, 10700 Puritan Ave., Detroit 38, Mich.

positions available

EXPERIENCED DIE DESIGNERS AND DIE MAKERS—wanted. Steady employment. The Payne Tool and Engineering Co., Springfield, Ohio.

WELL-ESTABLISHED—wood and steel furniture manufacturer, employing 1700, in a lakeside, northeastern Wisconsin city of 12,000 population, has an opening for a tool and die department foreman to supervise a captive tool and die department employing 20 tool and diemakers. The work involves the construction and maintenance of brake, progressive and draw dies for furniture and appliances. A journeyman tool and diemaker with supervisory experience is desired. Salary dependent on qualifications and experience. Write personnel manager, Hamilton Mfg. Co., Two Rivers, Wis., giving qualifications and desired salary.

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New cutting tool materials... through metallurgical research

Years of research, experimentation and comprehensive testing have been devoted to every type of product being manufactured at V-R. By working closely with all types of industry, this metallurgical knowledge is effectively applied to meet industry's ever-changing demands for new cutting tool materials.

Above is a V-R metallurgist checking specific gravity of a metal sample on an ultrasensitive scale. Research, such as this, provides the basis for developing new cutting tool materials; for example, VR-65, a new titanium cemented carbide grade, for ultra high speed machining on *all* types of steel.

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Progress in Production

STAMPING PROCESS TURNS OUT SMOOTH-EDGED BLANKS

A new high-speed stamping process eliminates shaving operations by producing blanks with straight, smooth edges in a single operation. The surface finish produced in the blank edge compares with that achieved by grinding. Accuracy of 0.0005 inch and closer is possible.

The process, developed by Hydro-Cam Engineering Co., is carried out in a triple action, high-speed hydraulic press on either coil or strip stock with special dies. Because the material is kept firmly clamped by the dies, there is no flowing or tearing along the line of the sheer.

Smooth-edge blanking die produces O-ring seal plates.

Used in stamping gears, gear racks, pieces with precision holes or contours, small extrusions and other parts that require smooth edges, the process can be carried out with steel of all hardnesses, brass, aluminum and copper. Smooth holes and edges can be achieved in thin precision parts from 0.010 to 3/16 inch thick.

MACHINE COMBINES WELDING AND ASSEMBLY OPERATIONS

Welding operations have been included in a new special purpose welding machine produced by United Welders, Inc., Bay City, Mich. Requiring only one operator, the machine produces 900 automobile oil-filter cartridges per hour. Each unit consists of eight parts which are assembled with four welding and two mechanical joining operations.

The machine consists of two independently controlled straight-line units joined by a storage-conveyor at the angle between them. Partial assemblies are mechanically transferred to each station and parts are added from hoppers or magazines. In operation, the operator inserts two parts of the assembly while sensing units assure complete assemblies at other key stations.

Mounting plates, are delivered to the first station of the first unit and positioned one at a time on the transfer mechanism. In the next station, the pilot of a fitting nut is slipped through the central hole in the mounting plate. These components are joined by a ring projection weld in the next station.

Two straight-line units combined as one automatic assembly machine. Production capacity is 900 units per hour.

After the upper gasket retainer is positioned on the partial assembly, it is projection welded to the mounting plate. This three-part subassembly is transferred into the storage hopper prior to use in the second machine unit.

In the first station of the second line, the lower gasket retainer is automatically loaded onto transfer fingers. The subassembly from the previous line feeds onto this retainer in the next station and they are projection welded together.

Neoprene gaskets are fed from either of two magazines. To insure uninterrupted operation, a sensing unit automatically switches feed from one magazine to the other when the first has been emptied. The gasket is expanded by a circular jaw and, as the partial assembly is elevated beneath it, is stripped off the jaw onto the gasket retainer.

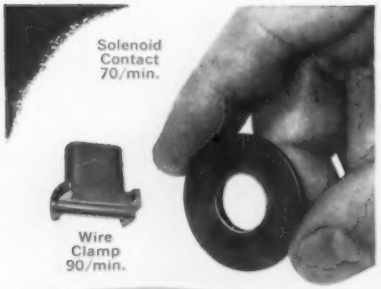
The operator has five mechanically idle stations where inner filter elements and springs are manually positioned on the assembly. Outer shells are fed to the next station by a magnetic conveyor and one is loaded into an upper clamp unit. The partially assembled filter unit is transferred into the station under the shell. The clamp descends and slips the shell over the inner filter element. At the end of this stroke, two spot-welding guns are fired to positively join the shell to the mounting plates. These welds supply the mechanical strength to the assembly so the unit can be installed on an automobile by holding onto the shell. In the final station, the filter unit is clamped between centers and the rotating lock-seaming rolls turn the bottom of the outer shell under to provide an oil-tight joint.

In projection welding stations, the electrodes are spring-loaded and of low-inertia design to permit maximum follow-up during the projection weld. Experience has shown that sound welds are achieved consistently.

Although this machine has been designed for a specific series of assembly operations, it is typical of the advantages that can be gained by combining welding and mechanical operations in automatic-assembly machines. Some machines of this general type are being designed to include pre and post-assembly machining operations.

NEW TOOLS INCREASE LATHE OUTPUT

Equipped with new tools, a limited-power lathe is efficiently contour machining welded steel cylinders at Conco Engineering Works, Inc. The 20-inch-

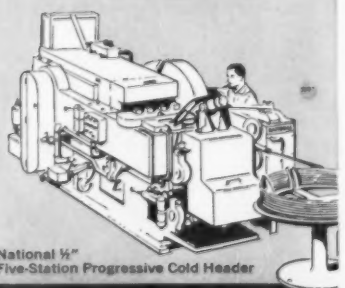


Still more parts from wire!

These important parts are cold-formed from wire, start to finish in compact, efficient National Cold Headers.

Practically scrapless, all these parts achieve remarkable savings over past methods.

If you make odd-shaped parts, may we help you evaluate them for cold-forming from wire? Better yet, come to Tiffin, witness our demonstrations and let's discuss your work.



National ½" Five-Station Progressive Cold Header

NATIONAL MACHINERY CO.

TIFFIN, OHIO, U.S.A.

HARTFORD DETROIT CHICAGO

Use Reader Service Card, CIRCLE 71

diam cylinders are fabricated from $\frac{5}{8}$-inch-thick stock by butt welding and are 44 inches long.

A Turchan tracer and three Kennametal positive rake tools on the turret permit the lathe to perform the necessary facing and contour machining of the cylinders. The machining operations are run at 480 fpm and the cuts are from $\frac{1}{8}$ to $\frac{3}{8}$-inch deep.

First, a tool with a triangle carbide insert makes a step cut on the chuck

Lathe and positive rake tool are machining steel cylinder.

end of the cylinder to establish a gaging point for subsequent operations. The feed is 0.008 inch. A second tool is then used on the tailstock end of the cylinder to machine the four brackets welded there, face the end and machine the step. Feed is again 0.008 inch.

A tool with a square carbide insert makes the 42-inch long contouring or tracer cut. The cut takes 12 minutes and is made with 0.037-inch feed. Each cutting point on the square insert is good for three cylinders; thus, each insert edge can be used for 17,829 lineal ft or more than three miles of cutting. Each cutting edge removes approximately 1200 lb of metal.

SWAGING AIDS ATOMIC POWER

Uranium dioxide is a common fuel for nuclear reactors because of its stability under irradiation, its chemical inertness to many coolant materials and its ability to retain fission products. Yet the fuel is limited by its low thermal conductivity and low thermal shock and stress resistance.

By adding tiny fibers of molybdenum to the uranium dioxide powder, inserting the mixture in thin cladding tubes and then swaging, Martin Nuclear Div. has improved the material's thermal conductivity by 30 percent and more. Uniform distribution of the mixture

New "Series 333" Drills for Drilling Cast Iron!

ACE

CARBIDE DRILLS

Whatever your carbide drill requirements may be . . . whether solid carbide or carbide tipped . . . it always pays to make sure you use an "ACE". Their "ground-from-the-solid", highly polished flutes have keener, stronger cutting edges. And that means finer accuracy, longer tool life, and lower drilling costs for you!

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NEW CATALOG covers the entire line of Ace "Ground-from-the-Solid" High Speed Steel and Carbide Drills, Reamers, Drill Blanks and Special Drills. Send for it today!

ACE DRILL

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ORIGINATORS OF "GROUND-FROM-THE-SOLID" DRILLS

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was obtained by wetting the fibers and adding the UO_2 gradually. Pressing the damp mixture in the tube or compacting pellets before insertion into the tube produced radial alignment of the fibers.

This new technique eliminates the expensive use of enriched uranium, necessary when thermal conductivity is increased by dispersions of the fuel in metal, which in large amounts dilutes the fuel content.

Swaging the mixture of molybdenum fibers and uranium dioxide powder increases density to between 84 and 87 percent of theoretical limits. It eliminates a costly hot pressing operation that previous development efforts assumed necessary to produce dense bonded compacts. Hot swaging increases density by from two to three percent.

The results of thermal conductivity measurements of the prototype fuel elements show that when metal fibers make up 10 percent of the fuel mixture by volume, the thermal conductivity is increased by about the same percentage. A 15 percent mixture, however, shows almost 30 percent improvement in conductivity; and on the basis of preliminary tests, a 20 percent mixture appears to boost conductivity by at least 60 percent. These measurements were conducted up to 200 F.

CONTROL SYSTEM PROMOTES PRESS SAFETY

Punch press operation is safer when both the operator's hand are in use. Based on this principle, a dual interlock control system developed by Westinghouse Electric Corp. permits operation of the press clutch only when two palm type pushbuttons are simultaneously depressed.

By means of a solenoid valve the interlock system controls an air cylinder which, in lieu of the conventional linkage, operates the clutch. Depressing the pushbuttons causes the press to cycle only once no matter how long the buttons are held down. For a repeat cycle, the buttons are released and then closed again. Release of either button will de-energize the equipment, which cannot be re-energized until both buttons are released and again depressed simultaneously. The system has no moving parts and is designed to fail safe in the event any of its components fail.

SLOCOMB
MICROMETERS

Whatever your micrometer requirements, chances are Slocomb has it. Slocomb micrometers range from the 1" conventional micrometer calipers to 60" Rigitube models. Airfoil, tube, screw thread and sheet metal types . . . just to mention a few of the many available specials . . . as well as the new Slocomb Snap Gage micrometer, designed to eliminate a complete line of fixed snap gages.

All Slocomb micrometers have as standard optional features your choice of terminals . . . carbide, 60° points, ½" diameter discs, ball ends or rounded anvil.

SPEEDMIKE

Another Slocomb first! Digitally read, the new Speedmike achieves the ultimate in measuring speed and accuracy. Yes . . . you can have Speedmike's "direct reading" feature on other Slocomb micrometers.

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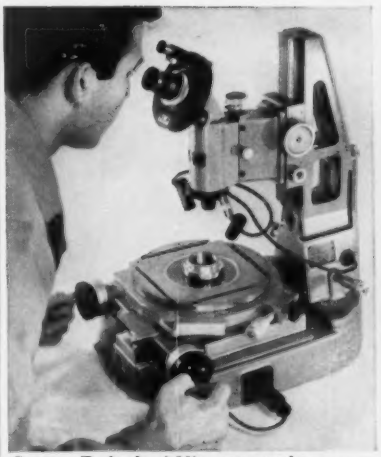

Gaertner Toolmakers' Microscope used to measure typical piece part. Co-ordinate range 4" x 2".

Precise measurement to 0.0001" and 1 min. of arc

Gaertner Toolmakers' Microscope

Here is a reliable, easy-to-use microscope for precise measurement of piece parts, tools, dies, thread gages, templates, jigs, fixtures, etc. Ideally suited for making a wide variety of precision measurements and is especially valuable in reducing rejects in production work.

With the Gaertner Toolmakers' Microscope you make direct, non-destructive measurements — no contact, no distortion, images are sharp and clear. It is a basic measuring instrument for inspection depts., gage labs, tool and die and model shops, industrial and research labs.

The Gaertner Toolmakers' Microscope has been proven in use by U. S. Government Gage Laboratories, and by prime contractors and their subcontractors. With all parties using the same measuring instrument, inspection procedures are co-ordinated and disagreements and rejects minimized.

Features that help you get
HIGH SETTING AND REPEATING ACCURACY

- Low, compact built-in rotary stage reads to 1 minute of arc throughout 360° range.
- Minimum overhang of stages.
- Full 2" precision-lapped lead screws with correction device.
- Straightforward, direct, uncomplicated optical system.

Features that assure you of
EASY, CONVENIENT OPERATION

- Independently rotatable cross hairs in protractor ocular speed up measurements, simplify measuring procedure.
- Convenient location of ocular eyepieces for ease of reading.
- Built-in transformer and plugs for all illuminators.

Modifications and accessories to
MEET YOUR EXACT REQUIREMENTS

- Thread and radius templates, camera and spotting attachments, fine motion focus, variable magnification available.
- If you have a special measuring problem, our staff of representatives will be happy to consult with you. The service and engineering facilities of the manufacturer are always immediately available to help you.

Write for Bulletin 147-56
Designed and manufactured by

The Gaertner Scientific Corporation
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Service you can depend on. Where socket-type specials are concerned—from extreme configurations to near-standards—you can rely on SPS for prompt quotations, strict quality control during manufacture, and delivery on schedule. The special fasteners you need will be on your assembly line in time . . . and they will fit with precision.

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Design confirmation. SPS does more than simply meet specifications. Our engineering and methods people not only interpret your prints; they also analyze them—carefully. If there is a question (socket depth, fillet radius, etc.), we double check with you. Certainly no one knows all the answers, but sometimes we can offer a suggestion that may help increase fastening reliability and thus increase overall reliability of your finished product.

Production facilities second to none. Whatever your requirement in specials, SPS has the facilities to produce it in the quickest, most economical manner. Special configuration, special material, special threads (metric, for example), special plating or surface treatment, special tolerances—we are handling such problems daily on a volume basis. Further, we also supply the special keys needed for installation of non-standard or difficult-to-reach threaded parts.

For more information or service, see your local SPS distributor or contact Standard Pressed Steel Co., SPECIAL INDUSTRIAL FASTENER Division, SPS, JENKINTOWN 37, PA.

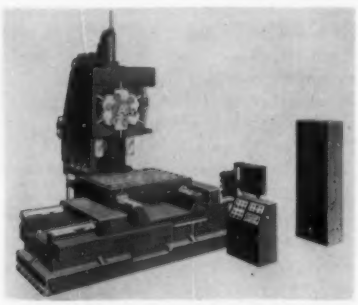
SPS

where reliability replaces probability

TOOLS of today

Turret Index Machine

Offering wide flexibility, this six-spindle model AA drills, taps, reams, counterbores and faces automatically. Its two-axis positioning table moves 30 x 20 inches and positions to plus or minus 0.00025 inch. It has preselected speeds, feeds and tapping cycle for any or all of the six spindles, and positive stops with dwell for accurate facing and counterboring. Spindles are heavy-duty alloy steel mounted with taper



roller bearings, and are available with straight bore for No. 3 Morse taper ASA adjustable adapter assembly or flanged nose for stub nose collet chucking tool for light milling operations. The turret column ways and the positioning table ways are hardened and ground. Lower column base is massive in construction and the base and table have ample coolant capacity.

The American Tool Works Co., Pearl at Eggleston Ave., Cincinnati 2, Ohio. **Circle 301**

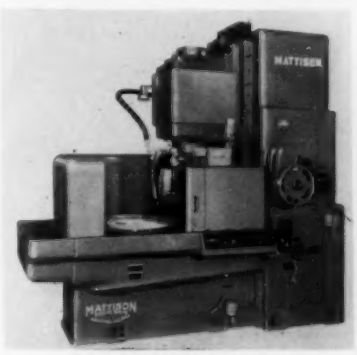
Numerical Control for Automatic Contouring

A numerical control system for metalworking machines which will make punched-tape programming as simple and economical for contouring operations as for standard positioning is the Mark Century control, which is expected to reduce the cost of automatic contouring control considerably below present-day levels. It will make possible quick, simple programming of a majority of contouring operations directly from engineering drawings, bypassing the need for expensive and lengthy computer interpolation. For those parts involving only straight cuts, slopes and arcs of circles, a control manuscript may be prepared directly from engineering drawings, ready for a typist to punch the finished program using a standard tape-perforating typewriter. Compact in size, the control incorporates the latest technology of solid state devices, including high-speed completely static, computer type logic circuits. Faster inherent operation of the control logic, coupled with a special high-speed perforated tape reader, means that tape-reading time will never be a limit to machine cycle time. Modular, compact design of the control will simplify both installation and maintenance. All electrical circuits incorporate printed circuit boards in plug-in modules, instantaneously removable for easier maintenance. A minimum number of common spare modules can be kept on hand by any user.

General Electric Co., Schenectady 5, N. Y. **Circle 302**

Surface Grinder

A one-piece, box type column backs up spindle hp as high as 125 on this No. 24 vertical-spindle rotary surface grinder. The machine, with capacity up to 48-inch diam, combines the manufacturer's grinding head with the box type column and increased hp. Accuracies measured in tenths can be combined with high-production stock removal. On average grinding operations, productivity can be increased by 50 percent or more without sacrificing flatness or finish. The one-piece column is bolted and keyed to the base, forming the equivalent of a single L-shaped Meehanite casting. Grinding wheel thrust is down onto the table and back into the column. Deflection and vibration are virtually eliminated. Uniform cross-ribbing in the heavy, double-walled base provides rigid support under the table. Both bed and column



are stress-relieved by heat treating. Resulting increased rigidity on a rough grind leaves less stock to remove during spark-out. Power spindle tilting converts the No. 24 for roughing or finishing in a few seconds. Wheel tilt is used to rough grind parts to within a few thousandths of final size. Location of the low point has no effect on final accuracy because the wheel is automatically returned to dead flat position for a finish grind without changing the setup.

Mattison Machine Works, 545 Blackhawk Park Ave., Rockford, Ill. **Circle 303**

Indexable Carbide Insert

Milling cutters with indexable carbide inserts that permit immediate renewal of the cutting edges at the

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No matter what the size or shape, when you need constant, accurate holding power, the sturdy "clamp-ability" of De-Sta-Co Toggle Clamps is the answer.

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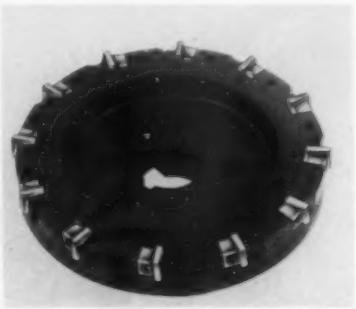
machine, make it possible for the operator to bring the cutter to sharpness in a short time. The square inserts may be quickly unclamped, indexed a quarter turn, and reset, providing eight tip changes per insert. Cost of resharpening the cutter is eliminated, as well as the extra tool inventory needed to keep a machine in operation when a cutter is out of service for grinding. A replaceable wedge located behind each insert prevents damage to the cutter



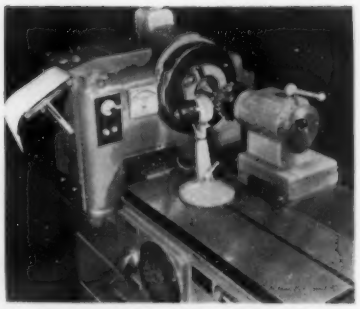
body in case of accident. Inexpensive replacement of the carbide inserts, combined with long life of the cutter body, lead to major economies in tool costs favorable to wider application of this type of cutter. The design utilizes precision ground insert blanks that are standard with leading carbide manufacturers and are readily available from local suppliers' stocks. Two-piece construction of the cutter body permits precision grinding of the insert seats during manufacture, assuring perfect alignment of each insert after indexing without further adjustment. The milling cutters are available in a wide range of sizes and styles including shell end mills, face mills, angle face mills, shoulder face mills, and half side mills.

Wetmore Tool & Engineering Co., 5320 E. Washington Blvd., Los Angeles 22, Calif. **Circle 304**

USE READER SERVICE CARD ON PAGE 169 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Sine-Line Lead Checker

Model 1218-A lead checker incorporates optical instrumentation for setting both the universal sine bar and an angular dividing head. The checker is independent of the operator's "touch" since all settings are visual. Angles can be set within 0.001 deg without use of gage blocks. With new components incorporated in this lead checker, it is possible to do conventional continuous checking or increment checking



through use of the scale on the tailstock. Leads of external or internal helical, spur and herringbone gears and worms can be checked from zero to infinity. Tooth spacing can also be checked with the dividing head. A chart recorder is integrally mounted in the head stock of the machine so permanent records can be made of tests. A transistorized amplifier drives the recorder pen or a large-scale electronic meter graduated in ten-thousandths. The amplifier is designed with plug-in molular units for quick field maintenance. Checking accuracy is high since the electronic indicator applies a load of less than 10 grams and has instantaneous response at high frequency. Leads of internal gears are checked with an angular offset stylus on the indicator. The indicator table can be operated from either the front or the rear of the checking machine. Gears with pitch diam up to 18 inches can be checked with repeatable accuracy of 0.0001 inch in either laboratory or production use. Maximum distance between centers is 24 inches.

Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich. **Circle 305**

Automated Parts Handling System

Completely automatic, this fully integrated parts handling system is available for high-speed manufacturing, assembling, counting and packaging and can be adapted to any machine. A vibratory parts feeder has an automator to orient the parts into the required position and feed them into a chute for delivery to the use point where an escapement releases them singly or in lots, as required. A vibrating storage-supply hopper holds parts and supplies the automator bowl on demand of the control maintained by a bowl level limit switch working from the depth of parts in the bowl. The bowl level limit switch may be preset for a maximum and minimum depth of parts, thereby controlling the quantity of parts in the bowl at all times. The

vibratory parts feeder has a feed rate of up to 90 fpm; has cast aluminum, anodized, or fabricated mild or stainless steel bowls; and is complete with all controls. Standard sizes are 5, 8, 12, 18, 24, 30 and 36-inch diam, with either clockwise or counter-clockwise

feed direction. The vibrating storage-supply hopper is constructed of mild steel and equipped with a standard bin vibrator. Sizes are 1, 2, 3, 4, 7 and 10-cu ft capacities. The chute and escapement are constructed to suit the configuration of the part being handled.

General Automation, 2315 W. Magnolia Blvd., Burbank, Calif. **Circle 306**

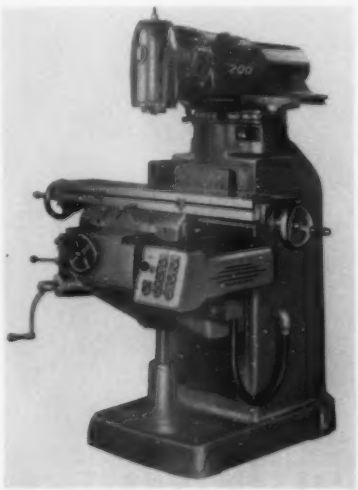
Magnetic Particle Inspection System

A magnetic particle inspection system is used to detect defective welds, cracks, inclusions and other flaws in such materials as are currently inspected by magnetic particle systems. The new system has been used to determine, nondestructively, the diameter of spotwelds in stainless steel, such as cold-rolled types 301 and 201 and in precipitation hardening grades such as PH-15-7MO and AM355. Since there is a direct correlation between the diameter of a resistance spotweld and its tensile shear strength, the system can supply very reliable weld strength information. The system has specially developed solutions that contain magnetic particles. When sprayed or poured on the surface of a part, the magnetic particles are free to migrate in the solution. When the solution sets up as a strippable plastic film, the magnetic particles are frozen in place. The first two solutions being offered to industry have setting-up times of twenty minutes and eight minutes respectively without the aid of external heat or drying. The solutions are formulated to offer good visual contrast between the particles and the part. The patterns of magnetic particles clearly show the shape and size of a spot or other type of weld, making it easy to detect a defective joint. The patterns may be viewed on the part and washed away or they may be stripped from the part, viewed, and filed away for reference. Copies of the patterns are readily obtained by passing the system's films through reproduction equipment. In addition to these proprietary solutions, specially designed magnetizers provide a relatively uniform magnet field over a fairly large area, allowing for sensitive detection of very faint local differences in magnetic properties within the working area of the magnetic field. Additional applications for this system will be magnetic field studies and the determination of grain direction in sheet metal and sectional forgings.

The Budd Co., Box 245, Phoenixville, Pa. **Circle 307**

Numerically Controlled Mill

Numerical control automatically guides the movement of this mill, slides in the three axis, eliminating the errors and limitations of manual positioning and machining. Numerical data is taken from design information and transferred to the control system. The



time consuming jobs of positioning templates and tools, laying out cuts, hand gaging and checking are eliminated. Additionally, the machine provides reduction of waste, preparation time and plant investment. It assures greater productivity and constant accuracy.

Famco Machine Co., Kenosha, Wis. **Circle 308**

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AIR-OPERATED TOGGLE CLAMPS

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De-Sta-Co air-operated clamps are built to give long, trouble-free service... hardened bushings and pivot rods are standard of the many quality features.

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The instruments shown here are part of a complete line of precision DIAL TEST INDICATORS of all types — Write for brochure!

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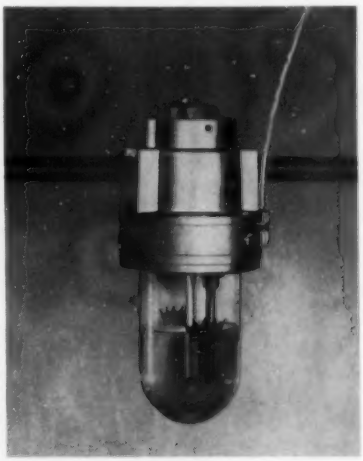
Lubrication Device

A significant development in the lubrication of compressed air operated equipment, a pulse lubricator, delivers exactly the required amount of oil to the spot where lubrication is needed. The system operates on pressure variations (pulses) and is entirely independent of air flow rates and duration of flow periods. Because the outlet end of the oil delivery line can be placed in any location, oil delivery to the exact spot desired is assured without the



need for costly, auxiliary pressurized oil supply. Advantages of the unit include positive lubrication of air-operated equipment even when such equipment is located in high, overhead places or when air flow through the lubricator is very low and/or infrequent. The device delivers a metered amount of oil and controls the amount of oil feed accurately from "very rich" (a drop every 3 or 4 pulses) to "very lean" (a drop every 100 or more pulses). In addition, substantial quantities of oil are saved because it is not necessary to flood the air line with oil in an effort to get a little to the operating equipment. This eliminates hazardous oil deposits and objectionable working conditions created by oily exhaust air.

Hannifin Co., Des Plaines, Ill. **Circle 309**

Tracing Attachment

A new self-contained tracing attachment is equipped with its own complete electrical and hydraulic power supply system. The attachment rough cuts and finishes in proper sequence,

switching from rough to finish automatically. Cycle control is fully automatic with rapid traverse on the return. With a special switch gear, the machine is capable of making an unlimited number of passes. The all-hydraulic tracer cuts in both directions and is capable of making a full ¾-inch diam reduction on a single pass. Maximum tracing length is 30 inches and stroke is 4 inches. Pushbutton controls are operated from an independent movable control station. The machine is equipped to do matching profiles ID as it does OD through use of a dual adjustment template arm.

Man-Au-Cycle Corporation of America, Brooklyn 32, N. Y. **Circle 310**

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Horizontal Mill

This horizontal milling, drilling and boring machine is available with 3⅜-inch spindle. Tape console and position measuring unit is a Warner and Swasey Tele-Probomat system. Tape is standard one-inch eight-channel paper or mylar with binary code numerical data prepared with Freiden flexowriter or with Warner and Swasey key punch. Tape reader can be used with key punch to duplicate tapes if desired. Read-out units on each axis position to 0.001 with repeatability to 0.0005. Standard tape system is three axis for control of head, table and saddle movements. Control and drive is applied to each axis in sequence only for accuracy and for simplification of part work planning. Numerical positioning input information can be dial input or tape input. Zero-set is included for initial part positioning and recheck can be made at any time. Automatic programming through the tape will control the machine through all movements required by a tool, including positioning the work in three directions as many times as required; start or

How efficient are Joydex cutters? We quote from a recent performance report: "Facing and rough milling a chrome-moly vanadium casting (Brinell 250) to a depth of ⅞" at cutting speed of 200 SFPM, the 12" dia. Joydex milled approximately 300 cu. in. per blade edge. Performance was beautiful."

Send for "Joydex" Catalog.

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Springfield, Vermont, U.S.A.

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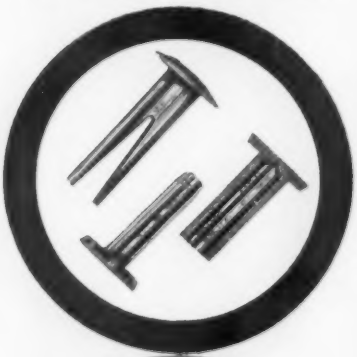

The 'in-place' cost of a fastener is what really counts to cost-conscious production men. By deciding on inexpensive Milford tubular rivets as a fastening method and installing them with Milford automatic rivet-setting machines, design and production engineers are eliminating costs at the initial production stage rather than trying to reduce costs later at the assembly line. Write for more information.

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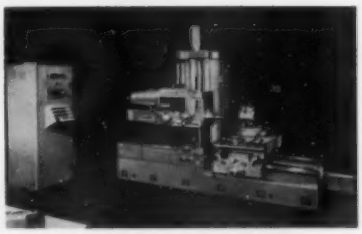
TOOLS of today



stop feed in either direction; start or stop rapid traverse in either direction; engage or disengage feed drive in any axis for start and stop spindle rotation. Auxiliary functions such as coolant start and stop and automatic clamping are also included. The tape console can be switched out at any time and the machine operated from its general purpose control stations for additional operations such as removing excess metal from an oversize casting, boring and gaging a particular hole to an unusual accuracy requirement or adding operations on one part out of a lot run. General machine data includes $3\frac{3}{8}$-inch spindle diam with No. 5 Morse taper, PDQ or No. 40 taper. Spindle traverse is 24 inches with hand feed and power feed. Table size is either 28 x 44 inches or 36 x 74 inches. Table travel is 30 or 60 inches. Head travel is up and down 30 or 48 inches. Saddle travel, in and out, is 24, 48 or 72 inches depending on bed length.

Portage Machine Co., 1054 Sweitzer Ave., Akron 11, Ohio. **Circle 311**

Ultrasonic Measuring Instrument

Completely transistorized and battery-operated, this ultrasonic instrument measures wall thickness between 0.25 and 2.50 inches. The portable unit gives instantaneous reading by simply placing a transducer on the surface to be measured and turning a dial. The SO-300 is housed in a high impact-proof plastic case which measures $8\frac{1}{2}$ x $9\frac{1}{2}$ x $11\frac{1}{4}$ inches. A separate carrying case for batteries is equipped with shoulder straps for use outdoors. The unit measures with an accuracy of plus or minus one percent when calibration is checked during tests against known sample of the same material. Three knobs provide complete control of the entire test procedure. To determine the thickness of a material, the operator selects the correct range and places the transducer on the surface to be measured, then rotates the harmonic scale disk until division lines coincide

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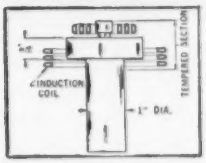
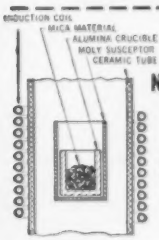


Punch Heads Selectively Tempered

Diagram shows arrangement for selectively tempering heads of alloy steel punches. The use of a combination type solenoid and pancake induction coil reduces hardness from Rc 55/56 to Rc 41/44, improving resistance to brittle fracture at the head of the punch. In this case a heating cycle of 55 seconds provides uniform tempering. A multiple position fixture, processing 4 pieces at one time, speeds up production.



Heating Non-Conducting Materials To High Temperatures

Laboratory analyses frequently require heating of non-conducting materials to temperatures of 3,000 to 3,500° F. in vacuum or special atmosphere. This can be accomplished by induction heating with the aid of a metal susceptor. Diagram shows the fusion of mica samples in an alumina crucible, using molybdenum susceptor. A ceramic tube surrounding the susceptor isolates the work for fusion in a vacuum. The molybdenum susceptor is heated by induction, which in turn, heats the crucible by radiation.

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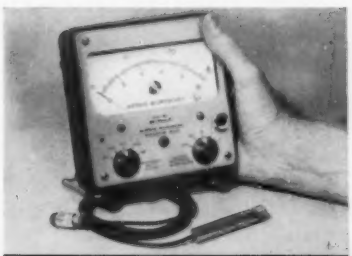

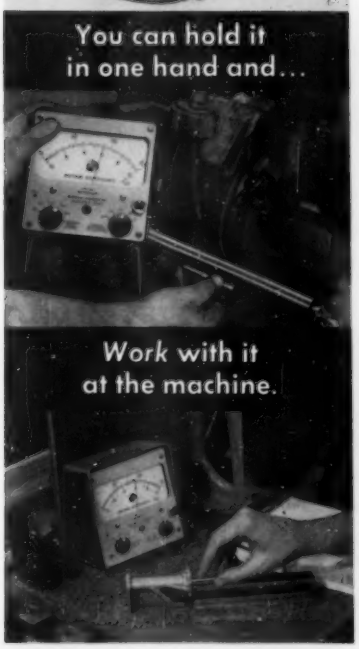

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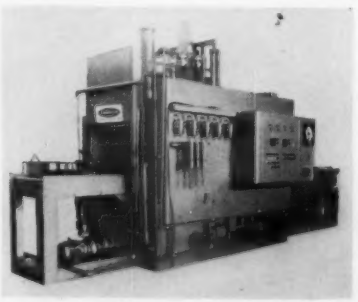
most accurately with the light pattern caused by a rotating neon bulb flashing in phase with scanned frequency. The thickness indicator then points to the direct thickness reading, in inches, on the outer scale. Both quartz and the more sensitive litium sulphate transducers can be used with the SO-300. A liquid couplant must be applied in order to transfer ultrasonic vibrations between the transducer and the test material.

Magnaflux Corp., 7300 W. Lawrence Ave., Chicago 31, Ill. **Circle 312**

USE READER SERVICE CARD ON PAGE 169 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Multipurpose Furnace

The automatic furnace illustrated is atmosphere controlled and is equally effective as a multipurpose furnace in a heat treating department or for processing in a continuous production line. It can be used for carburizing, carbonitriding, carbon restoration, normalizing, annealing and hardening up to 1850 F. The unit can be built with work space dimensions up to 32 x 50 x 26 inches. It can accommodate up to 1500 lb of work in any one load. Bearings, instrument parts, tubes, gears,



bushings, shafts, hinge pins, bolts, nuts, chains, screws and fasteners are typical of the large and small parts that may be heat treated. Automatic operation makes the loading of the furnace easy, fast and safe. Automatic control minimizes human error. Its flexibility allows for processing a wide variety of operations and time cycles over a broad temperature range. No moving parts of the work transfer system are exposed to excessive heat in

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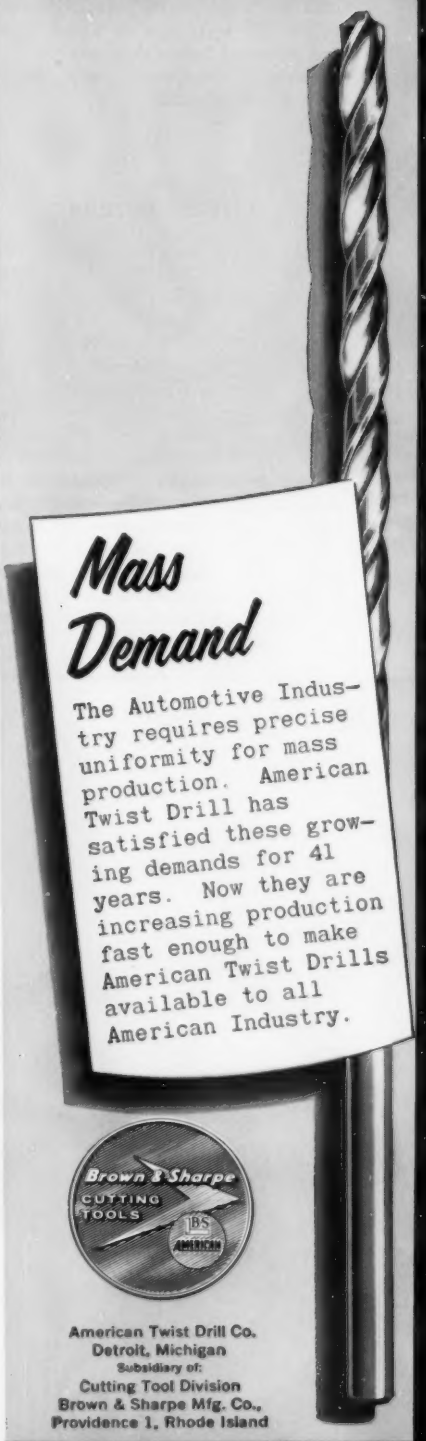
AMERICAN


Mass
Demand
The Automotive Industry requires precise uniformity for mass production. American Twist Drill has satisfied these growing demands for 41 years. Now they are increasing production fast enough to make American Twist Drills available to all American Industry.
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CUTTING TOOLS
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American Twist Drill Co.
Detroit, Michigan
Subsidiary of:
Cutting Tool Division
Brown & Sharpe Mfg. Co.,
Providence 1, Rhode Island

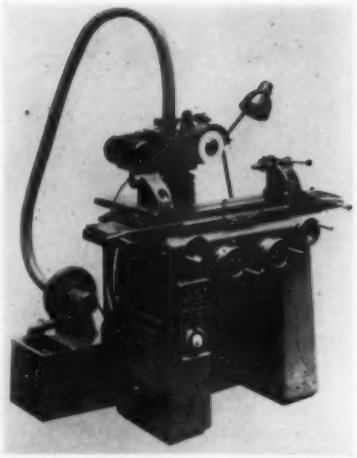
AMERICAN

the furnace. The furnace is normally supplied with an integral oil quench tank and a completely prewired control panel. All equipment is wired, piped and pretested before shipment.

Sunbeam Equipment Corp., Meadville, Pa. **Circle 313**

Tool, Cutter Grinder

Tool and cutter grinder model AUL 500 has a patented grinding wheelhead that produces high versatility. The table rides on precision roller bearings. The machine easily handles any type reamer, tap, threading die, helicoidal drill, hob, single point turning tools, circular saws, inserted milling cutter bits, angular cutters, gear cutters and other type cutting tools. It can also be utilized as a standard cylindrical, internal, tangential and surface grinder. The head spindle swivels 360 deg and switches easily from horizontal to vertical position. The machine comes with twenty-five accessories to meet practically any tool grinding problem. It has



an 8-inch swing over the 6 x 36-inch table, a 20 inch distance between tailstocks and 20 inch longitudinal travel. Cross travel is 8 inches. Lubrication to the ways is by a one-shot system.

S & S Machinery Co., 140 53rd St., Brooklyn 32, N. Y. **Circle 314**

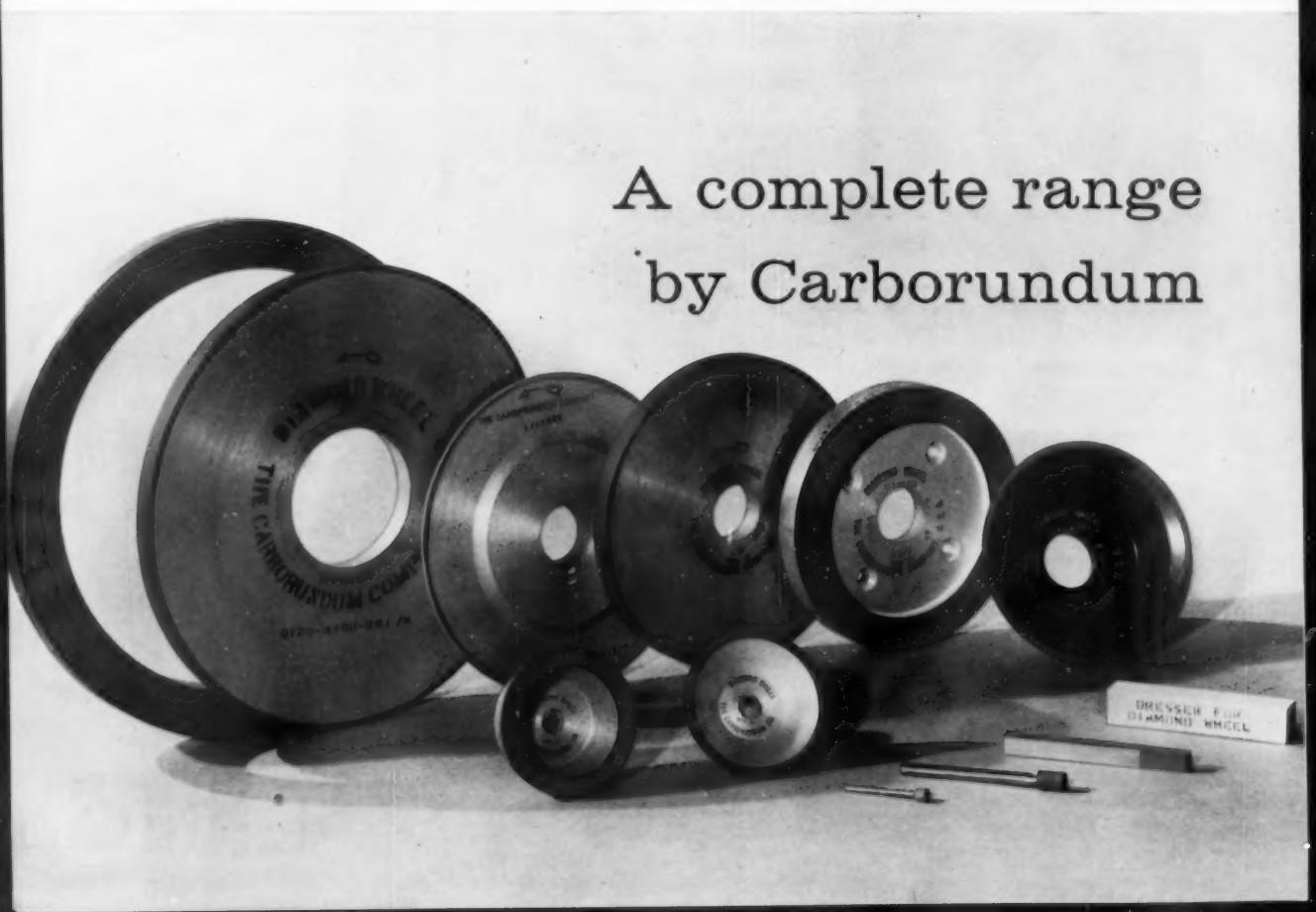
Carbide Inserts

Triangular carbide inserts with inscribed circle of 5/32, 1/4 and 3/8 inch are available in screw-on or clamp-on styles. Minimum bore diameter of the screw-on type is 1.50 inches and that of the clamp-on type is 4.01 inches. Twenty-one unit sizes are available in zero, positive or negative rake angles. All units are adjustable in increments of 0.0005 inch on bore diameter per graduation on mounting dial.

Beaver Tool & Engineering Corp., 500 W. County Rd., Gaylord, Mich. **Circle 315**

Honing Machine

Design features of this compact honing machine save floor space, simplify operation and reduce maintenance costs. The model 3010 honer is available with 25, 35, 45 or 60-inch spindle travel. The machine will hone bores up to 10 inches at max stroke, and will hone large diam bores in shorter lengths. Since no auxiliary electric panels are used, floor space is reduced and external conduit is kept to a minimum. All electric controls are built into the two side panels of the machine. Shoulder height operating controls are removed from the area of coolant splash, and setup controls are protected



by lock and key to avoid undesirable tampering after the setup has been made. To change spindle speeds, the operator turns the two knobs on the right side of the head. One knob selects neutral, low or high-speed ranges, and the other selects the specific speed in either the low or high-speed range. Eight speeds are provided by a 10-hp motor with a V-belt drive. Stroke length is controlled by a dial mounted on the rear of the control panel arm. An electric hone expansion mechanism and bore sizing mechanism maintain size consistency within tenths of thousandths from bore to bore at high-production rates. When limitation of stone wear is reached, lights on the control panel warn the operator and interlocking controls prevent the start of a new honing cycle until new stones have been inserted. Compensation for stone wear is also automatic. A separate 10-hp motor powers the hydraulic reciprocation. To reduce maintenance problems, the hydraulic unit is located in the open at the back of the machine. Hydraulic controls and coolant pump are also in the open at the lower right side of the machine. The honer can short stroke at any point in the bore, and it is available with a dwell mechanism. A wide variety of fixtures and tables can be adapted to meet individual production requirements.

Barnes Drill Co., Rockford, Ill. **Circle 316**

USE READER SERVICE CARD ON PAGE 169 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Stamping Trimmer

Capable of shearing mild steel stampings up to 3/16-inch thick, Model 43 HVX can be adapted for trimming rectangular or odd shapes with inside corner radii as low as 3/8 inch. Illustrated

on the table top is a pneumatic hold-down device used for the trimming of round stampings. The machine can be mechanically or electrically modified for special-purpose use.

Whiting Corp., 15613 Lathrop Ave., Harvey, Ill. **Circle 317**

# of Diamond Wheels
for every industrial application

Carborundum offers a complete line of diamond wheels, natural and man-made, to meet every requirement of industry. Diamond wheels by Carborundum have been proven in service to give long, trouble-free operation with economy to the user.

Select from a complete range of shapes, sizes and controlled concentrations of diamond wheels in resinoid, vitrified and metal bonds. Carborundum offers you a wide choice of wheels for every diamond grinding and cutting operation.

Ask your local Carborundum representative for recommendations to meet your specific requirements; these wheels are readily available through your local Carborundum distributor.

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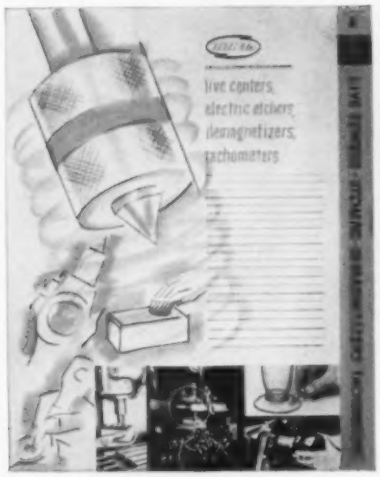
CARBORUNDUM®

if you use **LIVE CENTERS**

you need this

NEW CATALOG!



• Tells how to select Ideal Gold Band Live Centers to fill your needs exactly. Over 40 different sizes and styles in 4 models—**Universal, Pipe Point, Multi-Duty, Heavy-Duty**—custom quality performance at production prices.

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TOOLS of today

Production Rate Recorder

Better production rate analysis of key automatic machines is made possible by this portable instrument. The production rate recorder plots a complete log of production rate information for any machine directly on graph paper. It automatically integrates production data, constantly comparing actual rate with a predetermined standard reference rate. Any deviation from

standard is recorded by percentage on the graph. Rates are determined for definite sampling periods as desired. The instrument provides selection for periods of 1, 2, 4, 8 and 16 hours. It utilizes the Esterline-Angus strip chart recording mechanism; weighs about 24 lb; and operates on 115 volts, 60 cycles. A companion instrument, the time-speed recorder will monitor automated operations to split-second accuracy.

R. B. Annis Co., 1101 N. Delaware St., Indianapolis 2, Ind. **Circle 318**

Interchangeable Blade Counterbore

Adaptable to unlimited counterboring and spotfacing applications, high tool economy and control is accomplished by the interchangeable feature of this counterbore. A socket set screw secures the blade in the solid, one piece shank and pilot. A simple adjustment permits quick interchange of blade sizes or replacement. The blades have spooned cutting edges that cut clean precision holes and eject chips properly and can machine a variety of hard or soft materials. The blades are easily modified for a variety of multiple, one-pass cuts. When reverse or back counterboring, reverse ground blades are

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NEW SLANTS *to*

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RUBBER CUSHIONED ABRASIVES

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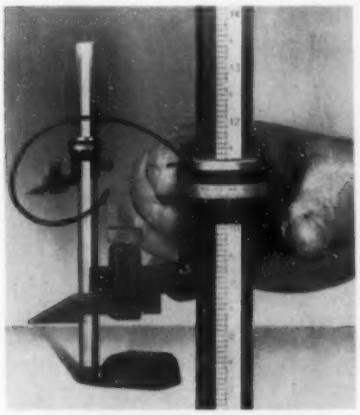
used. The medium-duty set ranges from No. 10 to ¾-inch cap screw size. The set consists of seven pilots and ten blades which accommodate the regular and the '60 series cap screw sizes. The heavy-duty series ranges upward from ½-inch pilot diam, with blade sizes to customer specification in high-speed steel or carbide.

Multi-Tool Co., 14512 Burt Rd., Detroit 23, Mich. **Circle 319**

USE READER SERVICE CARD ON PAGE 169 TO REQUEST ADDITIONAL TOOLS OF TODAY INFORMATION

Height Gage

Accurate to within 0.0005 per 12 inches, a low-cost precision built height gage is considerably faster than vernier type gages. It is clearly calibrated for split-second, direct readings without eye strain. The stem is hardened, stabilized, wear-resisting alloy and threads are carefully ground for accuracy. A hard chrome base supports the stem



and the scribe and clamp are easily adjustable to read zero at the base. Rapid settings are accomplished, as illustrated, by sliding the moving arm to the nearest 0.100 and rotating the dial to the proper setting. Standard sizes are 14 and 20 inches. Other sizes may be ordered for special applications. One scribe and clamp are provided as standard equipment. Metal cases may be ordered as accessories.

Speedline Sales Co., 12860 Fisk Ave., Warren, Mich. **Circle 320**

Hydraulic Cylinders

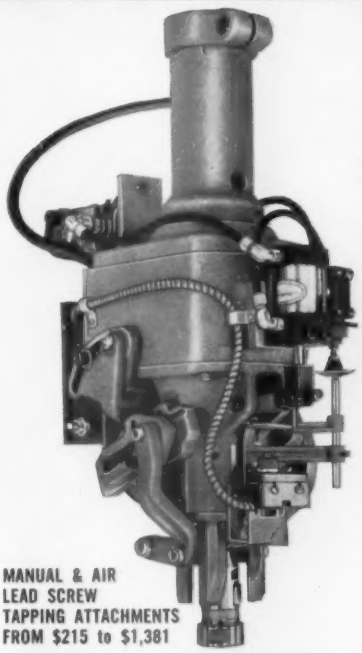
Power cylinders for use in medium-high pressure hydraulic service are designed for use with 1000-psi pumps and are available in bore sizes of from one through eight inches. The units have square head and rod design and provide case hardened and hard chromium plated piston rods as standard. Rods

HOW TO TAP UP TO
5,000* SMALL PARTS PER HOUR
WITH PRECISION AND AT LOW COST

WITH THE JARVIS AIR-OPERATED AUTOMATIC

LEADSKRU-MATIC

CHANGE PITCH IN SECONDS WITHOUT CHANGING LEAD SCREW



MANUAL & AIR
LEAD SCREW
TAPPING ATTACHMENTS
FROM $215 to $1,381

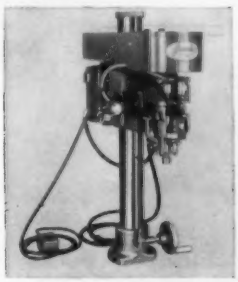
VOLUME PRODUCTION WITH PRECISION
This Air-Operated, Automatic Lead Screw Tapping Attachment converts your drill press into an extremely accurate tapping machine capable of volume production.

*5,000 SMALL PARTS PER HOUR
Using the **LEADSKRU-MATIC** as the basic machine, one of our customers built a small parts tapping unit comprising table, hopper feeds, holding fixtures, controls, etc., which taps up to 5,000 nut blanks per hour . . . **AUTOMATICALLY. And at a lower cost** than less versatile tapping machinery!

SHORT OR LONG RUN VERSATILITY
Besides the deluxe, air-operated, adjustable pitch model shown at left, you have, according to your requirements, a choice of electrically driven, manually operated adjustable pitch tapping attachments, or conventional single pitch units. No need to pay for extra features or parts that your jobs do not require.

LEADSKRU-MATIC FEATURES
WORTH YOUR INVESTIGATION

1. Adjustable Pitch — Change pitch in seconds without changing lead screw.
2. Exact thread depth control.
3. Forward and Reverse controlled.
4. Cannot break taps or rip threads.
5. 22 separate Pitch Adjustments with 2 models.
6. Longer tap life — Uniform threads.
7. Gives both speed and precision.
8. Accurate lead at all settings.
9. Adjustable stop settings for various depths.
10. Constant production with unskilled operators.
11. Fits any Drill Press.
12. Available with fixed or multiple spindle heads.



JARVIS AUTOMATIC, AIR-OPERATED
LEAD SCREW TAPPER ADAPTABLE
TO DRILL PRESS TABLE
Where complete automation is not desired, machine is equipped with standard hand-operated model lead screw units.

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Middletown, Connecticut

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Company .....
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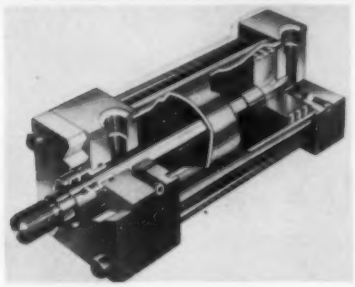
TOOLS of today

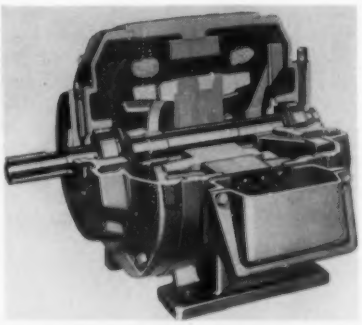


are drip-free and ports are leakproof. Fourteen mountings are available.

Power Cylinder Div., Hannifin Co., Div. of Parker-Hannifin Corp., Des Plaines, Ill. **Circle 321**

Weatherproof Motors

Open, weatherproof a-c motors with an epoxy encapsulated insulation system are available in frames 180 through 445U (1 through 25 hp) in all standard speeds and voltages. The stator



windings are epoxy resin-encapsulated for resistance to moisture, oils, dust, chemicals, acids and alkalies. All other components are also protected.

Reliance Electric and Engineering Co., 24701 Euclid Ave., Cleveland 17, Ohio. **Circle 322**

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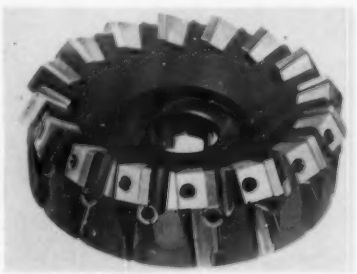
Disposable Cutter Inserts

Adjustable tapered pins provide axial support for individual disposable carbide inserts in a line of milling cutters. Because each insert can be axially adjusted to ten-thousandths of an inch, inserts with commercial tolerances can



be used for milling cutters without face runout. Pins have tapered bottom sections that are locked into the cutter body by differential screws. The top section of each pin is a straight-sided constant-rise cam with a maximum eccentricity of 0.030 inch.

Wesson Co., 1220 Woodward Heights Blvd., Detroit 20, Mich. **Circle 323**

Grinding Tool

Countersinking, chamfering and deburring can be done with this tool that curls the chip up and away from the work, leaving a drill-sized hole with no material forced into the opening and no ridge formed around the opening. Treated to decrease galling, the tool is made of vanadium alloys and M-2 high-speed steel. Sharpening is simple and the cutting angle easily changed to suit

NEW

lower cost

Hammond

Electrolytic Chip Breaker and Oscillating Cup Wheel Grinder

"2 in 1"
for Low and Medium Volume Tool Grinding

This new CME-66 provides low-cost electrolytic grinding for those whose requirements do not justify the larger Hammond models so widely used. It provides smooth oscillating cup wheel grinding on one end and chip breaker grinding on the other—"2 machines in 1" at low cost. You'll grind faster, rough and finish in one operation, eliminate heat fractures, and save between 80 and 90% in diamond wheel consumption. Write for bulletin today!

Hammond's OF KALAMAZOO Good Machinery Since '82

Hammond Machinery Builders INC.
1661 DOUGLAS AVENUE KALAMAZOO, MICHIGAN

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material or job requirements. Five sizes are available in three styles of 60, 82 or 90 deg.

Jancy Engineering Co., 508 S. Pine St., Davenport, Ia. **Circle 324**

Hydraulic Press

Equipped with a 20-inch index table interlocked through the hydraulic system for positive operation, this FD series 4-ton press has adjustable down and return strokes that limit ram travel

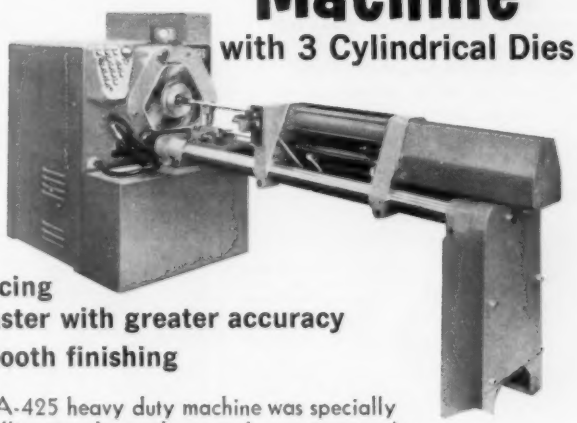
to a minimum. Electric pushbutton controls have both distance and pressure reversal. The 6-station press has an 18-inch gap and 12-inch stroke. Advance speed is 1100 ipm, speed of feed is 500 ipm and return speed is 1050 ipm.

Hannifin Co., 501 S. Wolf Rd., Des Plaines, Ill. **Circle 325**

Solenoid Air Valves

Two to ten manifold-base, four way, solenoid operated air valves can be combined to form common inlet, exhaust and conduit channels. When more than one pressure is to be used, valves

NEW **Involute Rolling Machine**
with 3 Cylindrical Dies



- for producing splines faster with greater accuracy
- for gear tooth finishing

The new Reed A-425 heavy duty machine was specially designed for rolling involute splines and serrations and for gear tooth finishing.

The precise tracking of the three self-feeding independently adjusted dies produces accurate involute forms. It gives greater tooth strength and better surface finish. The machine may be automated or equipped with a semi-automatic loading fixture.

For complete information write for Bulletin A-424-1.

REED ROLLED THREAD DIE CO.

Specialists in Thread and Form Rolling Tools and Equipment

HOLDEN, MASSACHUSETTS, U. S. A.

SRM-176

Sales Offices in: Buffalo, Chicago, Cleveland, Compton, Calif., Denver, Detroit, Englewood, N. J., Houston, Indianapolis, Milwaukee, Montreal, New York City, Phila., Pittsburgh, St. Louis, Syracuse, Toronto

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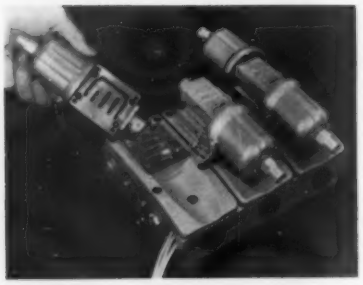
TOOLS of today



can be isolated and pressure-fed from each end of the manifold. Construction of the Model 551 ¼-inch valve permits interchangeable use of a single or double solenoid operation without demounting the valve. Double solenoid operation of a single solenoid model is achieved by removal of the end cap and plugging in of the solenoid.

Mechanical Air Controls, Inc., 10030 Capital Ave., Detroit 37, Mich. **Circle 326**

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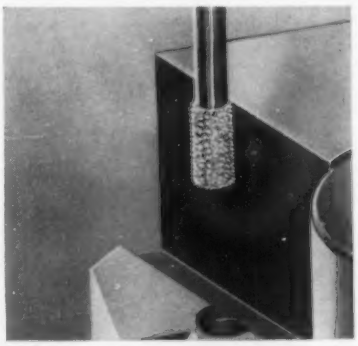
Diamond Mandrel

Grinding of small diameter holes in all types of material can be done with diamond mandrels available in sizes of from 0.018 to ¾-inch diam. Shanks are hardened and ground to a close



limit and diamonds are mounted under controlled atmospheric conditions by an electronic process. Holes as small as 0.022 inch can be ground accurately and rapidly. The mandrels can be used for internal as well as jig grinding.

Precision Diamond Tool Co., P. O. Box 274, Elgin, Ill. **Circle 327**

Wedge Screw Chuck

Utilizing a combination of pinion, gear plate, screw and wedge, this chuck

provides accuracy within 0.001 inch total indicator reading, repeatability within 0.0005 inch total indicator reading and high gripping power.

The Skinner Chuck Co., New Britain, Conn. **Circle 328**

Multispindle Drill Head

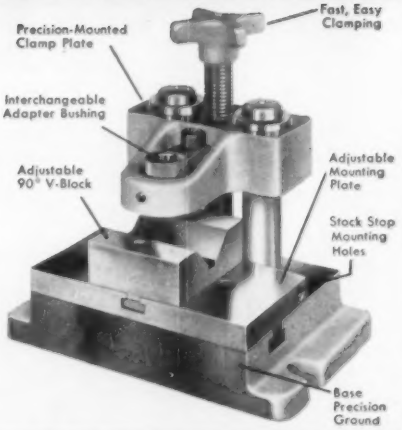
Designed to handle up to ⅝-inch drills in steel, this heavy-duty, adjustable, multiple-spindle head can be attached to any drill press. Adjustable spindles permit drilling or tapping a

REPCO *Time-Saving Tools*

ADJUSTABLE V-BLOCK DRILL JIG

Saves Set-Up Time— Increases Output

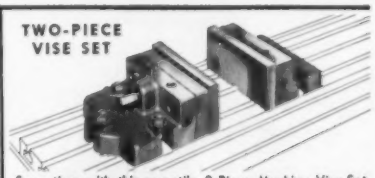
Here is a versatile and accurate V-Block that makes center and off-center drilling, tapping, and reaming easy and precise. Four-way V-block adjustment simplifies handling a wide range of work. Fast, easy positioning and clamping speed production. A centering locator plug and T-slots in the mounting surface plates assure fast, easy, on-center adjustment. Drill capacity #80 to ⅞" diameter. Handles stock from ¼" to 2" diameter.



TRUE-CENTER ADJUSTABLE TOOL HOLDER

The REPCO Adjustable Holder is a precision-built tool, having two-piece construction which provides fast adjustment of the main body to compensate for as much as ⅛" machine misalignment. Cuts down on tool wear, breakage, and scrap.

TWO-PIECE VISE SET

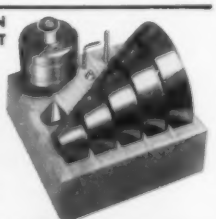


Save time with this versatile 2-Piece Machine Vise Set. Use as general-purpose vise, angle-block, or separate clamping device. Opening limited only to length of machine base. Light, accurate, rigid. Two sizes: 6" and 8".

CHUCK JAW TRUING-RING SET

This Ring Set saves time, cuts cost of boring jaws. With correct diameter rings at hand, you gain hours of productive time. Plated rings range from 1" to 4" by ¼" increments. Handy peg-type rack keeps rings in place.

COMBINATION LIVE-CENTER SET



Heavy-duty live center plus six interchangeable adapters, ranging from a point to 6¼" dia. ball. Saves costly set-up and machining time necessary to make large-diameter centers. Straight and various taper shanks available.

Write for complete information—Exclusive agent territories open.

REPCO ROCKFORD ENGINEERED PRODUCTS CO.

2334 23rd Ave., Rockford, Illinois

Use Reader Service Card, CIRCLE 92

America's First cO-Mpact Cylinder

INTERNAL KEY
TIE-RODLESS-TYPE SERIES 101A

Air 150 psi—Hydraulic up to 1500 psi
Fits where others won't
Meets JIC Standards, Bulletin 101A

This original space-saving cylinder is the most compact, streamlined and versatile cylinder available. It requires one-third less installation space and has a greater ratio of power to its size and weight than tie-rod-type cylinders with the same bore and psi rating. In addition, the ports can be rotated independently to any convenient location. It is easier to service. And by using a majority of standard parts and one or two semi-standard parts, this component gives you the advantage of special cylinders that do a better job at a nominal cost.

This compact unit has the lowest coefficient of friction. It is designed right to seal right . . . to make full-power starts on thrust and return strokes . . . to maintain perfect rod alignment . . . and cushion piston shocks. End plugs are tapped for universal mounting.

Coupon below brings Bulletin desired.

Bulletin 101A for Internal Key Tie-Rodless type Air and Hydraulic Cylinders featured above.

Bulletin 105A—Improved Tie-Rod (Heavy Duty) Cylinders Hydraulic 2000 psi; 3000 psi non-shock.

Bulletin 107—Automation (Heavy Duty) Air Cylinder for 200 psi operation.

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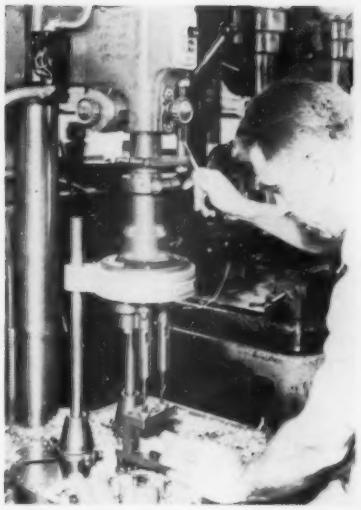

variety of hole patterns on a 6¼-inch diam circle. The head is available in two, three or four-spindle models. Built-in speed reduction allows use of Model 600 on small presses in jobs requiring large diameter multiple hole drilling or tapping.

Commander Mfg. Co., 4225 W. Kinzie St., Chicago, Ill. **Circle 329**

Lubricating Stick

Extreme-pressure molybdenum disulfide dry lubricant in stick form permits easy application of lubricating film to cutting and shaping tools, sliding areas of small machine parts and

other areas where dry metallic friction occurs on sliding surfaces. The stick is useful on small surfaces where oil contamination and temperature restrictions create problems.

The Alpha-Molykote Corp., 65 Harvard Ave., Stamford, Conn. **Circle 330**

Stub Router

Made in nine sizes, with diameters from 1/16 to ½ inch and lengths of from 1 to 1½ inches, Series 1546 solid carbon stub routers have single straight

Craft Industries, Inc. Use Popcorn Filler In HYSOL Epoxy Tool for Vacuum Forming

Demonstrating the versatility of HYSOL Epoxy Tooling Materials, Craft Industries, Inc., Buffalo, N. Y., used popcorn and puffed wheat to create a cellular structured filler for this vacuum-forming tool. The original pattern is unique, too . . . made of wood, paper and plaster. Cast in plaster, details in the design were refined and then a HYSOL Epoxy Tool was made from the plaster.

Over 2,000 parts have been produced and the tool is still in use. Long life, accurate detail, versatility and economy are cited by Craft Industries as their reason for standardizing on HYSOL Epoxy Tooling Material.

To find out how HYSOL Epoxy Tooling Materials can help you to new freedom in design, new versatility in tooling and greater economy in production, write for complete technical information.

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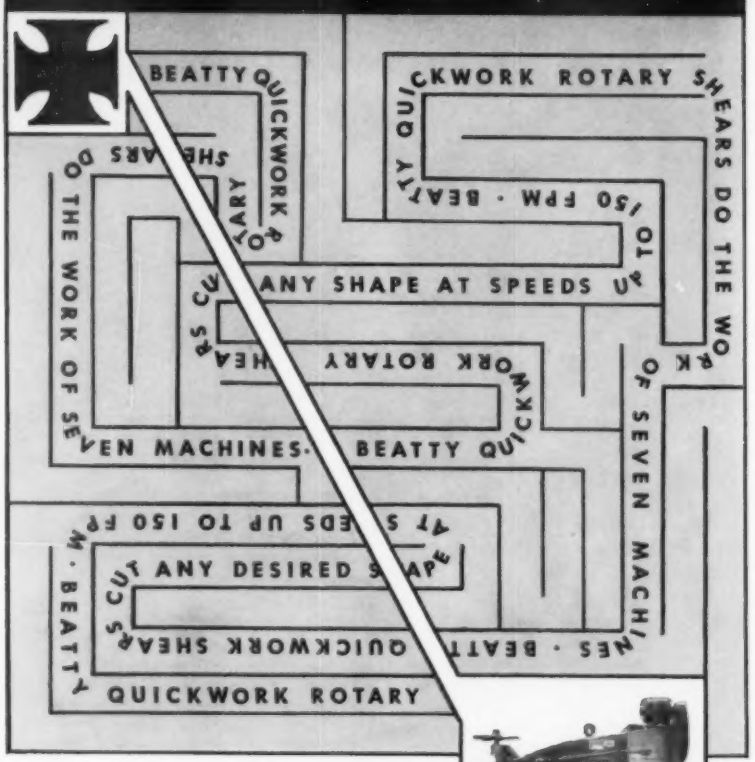
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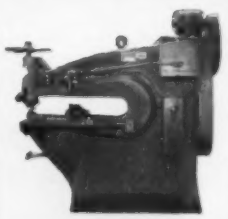

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A real cost saver for almost any type of metalworking shop, the Beatty Quickwork Rotary Shear does the job of seven machines. Its unique cutter design means greater speed, greater accuracy, greater ease of handling . . . all of which add up to greater economy. It's the proven way to cut costs of metal fabrication!

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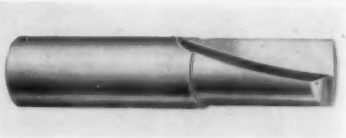


flutes, single shank and are single-ended. The right-hand cutting tools are recommended for routing glass, epoxy materials, Fiberglas, phenolics, bakelite and other abrasive materials.

The Antrax Co., Newton, Conn. **Circle 331**

Small Tapper

Designed for use with small drill units or drill presses, and just 1⅜ inches in diam, the "Midget" tapper will handle taps up to 10-32 in steel. The tool has a pressure-sensitive adaptation of the manufacturer's spring clutch drive that transmits torque in proportion to the pressure applied to the tap. Tapping torque is controlled

by the operator's finger pressure on the drill press handle. Pressure sensitivity provided by the clutch allows the operator to "feel" the tap through the work. Should the tap become loaded, hit a hard spot or "bottom," the clutch will slip, thus warning the operator. The tapper is equipped with a flexible rubber collet and is available with No. 1 or No. 2 Morse taper shank, as well as a ½-inch straight shank.

Commander Mfg. Co., 4225 W. Kinzie St., Chicago 24, Ill. **Circle 332**

Tap Driver

Designed for use primarily on multiple-spindle machines that take adjust-

able-adapter shank tools, this double-action tap driver compensates for a difference in the feed of the spindle and the lead of the tap. It can be used as a tension or compressor type driver.

The driver is made in six adapter sizes ranging from ½ through 1⅜ inches. Spring collets accommodate taps from No. 0 - 6 to ¾-inch hand taps or ¼-inch pipe taps.

Seibert & Sons, Inc., Chenoa, Ill. **Circle 333**

Abrasive Wheel for Air Grinder

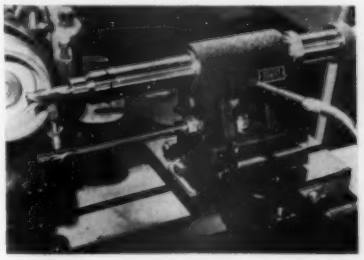
Solid rubber grinding wheel for use with coated abrasive belt is available with this six-inch straight air grinder. The wheel fits directly on the spindle of the grinder. Abrasive belts in desired grits can be slipped over the wheel to give it an abrasive perimeter. Under operation, the belts are held

positively by centrifugal expansion of the rubber wheel, without any mechanical locking devices or back-stand arrangements. Advantages of the process include quick changing of belts, continuous balance, and finer finishing because the resilient wheel hugs the work without bounce. The self-cleaning abrasive bands are ideal for flat work and weld grinding.

The Power Tool Co.,175 N. State St., Aurora, Ill. **Circle 334**

End Mill Sharpening Fixture

The precision spindle of this end-mill sharpening fixture is supported by an air bearing that minimizes friction, permitting smooth grinding motion of the spindle. This speeds up the tool sharpening operation, while allowing the operator to achieve utmost precision from his "feel" of the grinding action.



The fixture mounts directly on the table of any tool grinder. The spindle accommodates straight-shank end mills from 3/16 through 1¼ inch diam by means of a matched bushing set. Air from 60 to 90 psi floats the spindle in its precision sleeve. Positive air pressure prevents the entry of grinding dust. The No. 7 combination fixture consists of a sub-base, rocking head, finger-arm assembly, air-spindle assembly (including air spindle, sleeve, stop collar, and seven bushings), and tools necessary for servicing, all in a fitted case.

The Weldon Tool Co., 3000 Woodhill Rd., Cleveland 4, Ohio. **Circle 335**

Hydraulic Tracer Lathe

The Myford Mini-Kop hydraulic tracer lathe for small component duplicating, priced in the general range of ordinary copying attachments, is capable of high accuracy at the high speeds necessary for repetition turning. Hydraulic feed to the carriage replaces the gear transmission and spline shaft

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Roll-A-Finishing, cousin to Cogsdill's famous Bearingizing process, reduces 80 to 200 micro-inch surfaces to ± .0002 to ± .0025 tolerances and 2 to 10 micro-inch finishes. Special high speed equipment is not necessary; parts preparation is minimized since holes may be rough-bored to tolerances up to .005 before Roll-A-Finishing. Roll-A-Finishing exerts a steady rate of pressure against the work surface. The metal flows out ahead of the tool, filling microscopic valleys and leveling the peaks. Surface hardness is increased 5% to 10% with a penetration of .010 to .030. When the tool enters the hole, tapered rolls ride up the inversely tapered mandrel, increasing tool O.D., and exerting a predetermined rate of pressure. On passing through the work, the rolls glide down the mandrel to permit free return stroke.
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YODER ROTARY SLITTERS

If your slitting requirements call for coil widths from 12" to 60", in gauges from .015" to .250", the economy of purchasing Yoder Slitting Machinery can be yours. Operating a Yoder Slitting Line only one eight-hour shift per week, for example, could easily produce 35 tons of slit strands per week... or 1,820 tons every 52 weeks. At a slitting cost saving of only ½¢ per pound, the annual savings would amount to $18,200.

Additional savings can be realized through lowered inventory of mill-width coils – less waiting for delivery of special slit widths. Also, customer satisfaction will increase as you achieve faster completion and delivery of finished products.

At your request a Yoder sales engineer will study your plant operation to determine what equipment would most economically... and profitably... serve you, whether it be standard components or a completely specialized and engineered line.

Send for Yoder's illustrated text on slitting operations and equipment. It describes methods, time studies, operating cycles, material handling, and gives full specifications.

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ENGINEERING YODER MANUFACTURING
ROTARY SLITTING LINES

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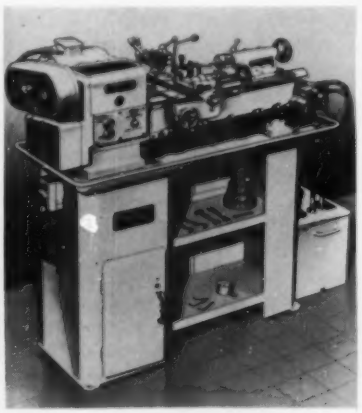
employed in conventional systems, enabling finger-top operation of the carriage motion with accurate length control. The reproducer unit incorporates control valve design that combines the sensitivity of potentiometric systems with the holding power of hydraulic lock types. Low stylus pressure permits use of unhardened templates for small batch work. Longitudinal repeat accuracy to deadstops in the order of 0.001 inch and repeat accuracy on diam from flat or round templates from 0.00 to 0.0005 inch can be obtained. A special feature is the machine's instantaneously and infinitely variable hydraulic longitudinal feed and fast traverse,



forward and reverse. The machine has a high-precision spindle bearing as well as a durable spindle which, throughout its range to 48000 rpm, is stable and unaffected by heat. The bed is hardened and ground on all bearing surfaces, while hardened and ground steel gib and keep plates and hardened and threadground feedscrews are standard. Specifications include swing over bed of 7 inches and distances between centers of 17½ inches. Maximum copying length is 14 inches, while maximum swing of the hydraulic reproducer, with both facing slide and reproducer mounted, is 2½ inches. Power is provided by a 2-hp motor in the headstock. Hydraulic pump motor is ⅓ hp.

Bentley Industrial Corp., 21-19 46th Ave., Long Island City 1, N. Y. **Circle 336**

Wide Bed Press

Model 45W is a 45-ton press with oversize features usually available only in larger capacity presses. Among specifications are: bed, 33 x 22 inches; ram face, 22 x 15 inches; opening

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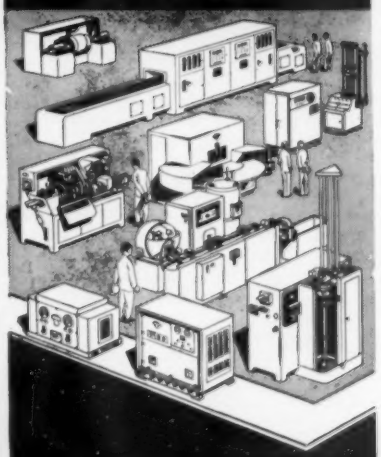

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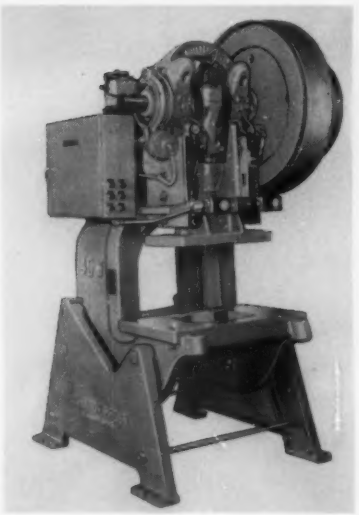
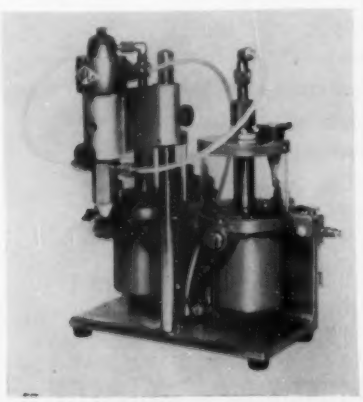


through uprights, 21 inches; throat depth, 12 inches and there is availability of a box type ram, as illustrated. The model is offered with a choice of mechanical or Wichita air clutch, flywheel or single geared drive and standard or oversize flange ram 26 x 15 inches.

Johnson Machine & Press Corp., 620 W. Indiana Ave., P.O. Box 426, Elkhart, Ind. **Circle 337**

Automatic Dispenser

Model 100 is a small, self-contained, high-speed machine for metering, mixing and dispensing two component plastic systems. Utilizing pneumatic, hydraulic, electrical, and mechanical principles, the machine automatically performs the following operations: (1) pumps a controlled amount of each component from its reservoirs to the mixing chamber; (2) cycles itself through a controlled motor driven shear and agitation mixing operation; and (3) dispenses the measured mixed charge with a positive drip-proof cut-off. The machine assures uniform volume, hardening and strength of dispensed two-component systems, and eliminates waste encountered in hand mixing. It is easily adjusted to a wide range of cycles and materials, simple to operate, easy to clean, and is designed to be used manually or adapted to any automatic or semi-automatic production line as a stationary piece of equipment.



New Plastic Corp., 1026 N. Sycamore Ave., Los Angeles 38, Calif. **Circle 378**

OBI Punch Press

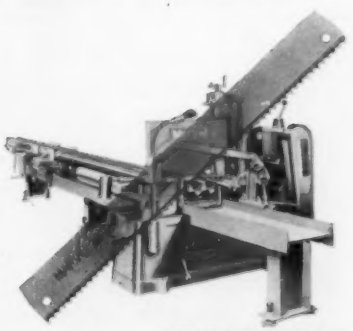
Five-ton open back inclinable punch press with a 12-inch depth of throat allows working to the center of a 24-inch sheet. The No. 5 machine can be used for high-speed production operations. Flywheel speed is 210 spm. The machine can be set up for continuous operation at this rate by removing the cam from the trip mechanism. Practical rate for single stroke cycling of the press would be 150 spm. Material stripper on the press is spring loaded and does not require adjustment for different material thicknesses, making it possible to quickly change from one job to another and to employ less experienced operators. After the punch and die set has been installed, it is only necessary to adjust the ram to compensate for punch length. Besides perforating or blanking metals, the press can also be used for material such as plastic, felt, leather, rubber

(Continued on page 171)

a message to owners of

MARVEL HACK SAW MACHINES

If you are the owner of a MARVEL Hack Saw Machine, check the name on the blades being used in it. If they are not MARVEL Blades, the chances are very good that you are not getting all the cutting-off speed, accuracy, and economy you paid for when you bought a MARVEL Saw. Consider this fact. The hack saw *blade* is the cutting tool that actually does the cutting job. If the machine is expected to deliver its full efficiency, the blade must possess a ruggedness comparable to that of the machine. Isn't it logical, then, that the blades you use be as carefully selected as the machine itself? Here is another fact: The MARVEL High-Speed-Edge Hack Saw Blade was designed specifically to withstand the heavy feed pressures and high cutting speeds your MARVEL Hack Saw can deliver. Only MARVEL UNBREAKABLE Hack Saw Blades can be safely tensioned taut enough to provide the maximum rigidity of the cutting tool necessary for accurate cutting-off; and at the same time, protect both the operator from injury and the machine from damage that so frequently occurs with "breakable" blades.



Why not be certain your MARVEL saw is delivering the high performance you had originally purchased, by using the only blade capable of utilizing the power and accuracy built into the machine? MARVEL Hack Saw Machines and MARVEL High-Speed-Edge Blades are an unbeatable combination. MARVEL High-Speed-Edge Hack Saw Blades are stocked and sold by leading Industrial Distributors everywhere.

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MARVEL Metal Cutting SAWS

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and gasket materials. A one-piece frame is reinforced at all points for minimum deflection whether light material or capacity load is to be run. Standard equipment includes motor, brake, flywheel guard, all electrical equipment, stripper assembly and punch and die holders. Accessory equipment includes floor legs with a foot trip control to convert the machine from a bench press to a floor model and an extension table gage that consists of a die holder and adjustable back and side gages.

O'Neil-Irwin Mfg. Co., 625 Eighth Ave., Lake City, Minn. **Circle 379**

Vertical Gage

A vertical gage has a direct measuring range between 0 and 4 inches from a master glass scale that is optically subdivided into 0.000025 inch. The instrument comprises a very heavy stand of sufficient height to permit an optional increase of the measuring range to 8 inches by resetting to a 4-inch gage block. The range of the scale in either case is 4 inches, in steps of 0.050 inch. The scale interval of 0.050 inch is subdivided by an optical micrometer in 0.000025 inch. All readings are on projection screens. Even though gage blocks are eliminated as masters, the measuring accuracy of the instrument is the equivalent of gage blocks and therefore well suited for gage controls, preceding high-speed operation.

Opto-Metric Tools, Inc., 137 Varick St., New York 13, N. Y. **Circle 380**

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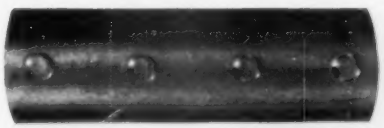
Allenpoint's deep, full-circle bite assures tremendous resistance to removal torque! Stays tighter longer!

When you need a set screw that you can depend on to stay tight under heavy strain and vibrations, specify ALLENPOINT. Here's why you can always depend on ALLENPOINT: proper design of the cup diameter results in a rugged grip that makes the full-circle pattern you see here... deep, strong, clean sockets allow full wrenching leverage... and uniform Class 3A threads assure a tight friction lock over the entire length of Allenpoint Set Screws.



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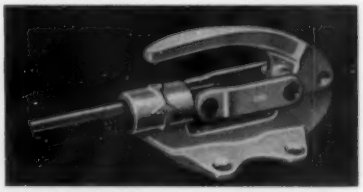
TOOLS of today

Push-Pull Clamp

Designed to lock in both the push and pull positions, the cast-steel-alloy base and handle and steel plunger enable the model 250 to stand hard use and still operate as a precision tool.

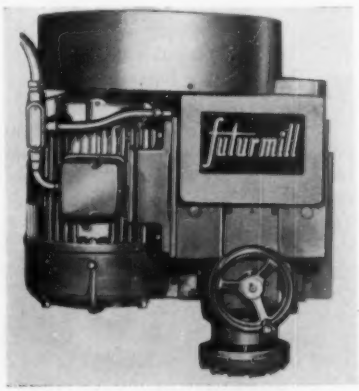


Over-all length is 11¼ inches. Over-all height in forward locked position is 4¾ inches. Base hole pattern is 2¼ inches wide and 2¾ inches long. Spindle travel is 3 inches. Center height of plunger is 2¼ inches. Spindle is tapped with ⅝ 11 x 2-inch hole. Weight is 5½ lb.

Wespo Div., Vlier Engineering Corp., 26935 W. Seven Mile Rd., Detroit 19, Mich. **Circle 381**

Adjustable Speed Milling Spindle

A lightweight adjustable speed milling spindle is designed for converting planers and older machines to competitive, rapid metal removal machinery. Model AS has an adjustable speed range of from 125 to 1100 rpm. Spindles range from 10 to 25 hp. Top



operating efficiency is obtained with a geared, changeable timing belt that produces a cushioned and positive spindle drive. The spindle is mounted in heavy-duty precision roller bearings, has a six-inch quill adjustment and weighs less than 1200 lb in the 10 and 15-hp models.

Futurmill, Inc., Pontiac, Mich. **Circle 382**

Field Notes

acquisitions

Taylor Fibre Co., Norristown, Pa., manufacturers of laminated plastics and vulcanized fibre, is acquiring **Dytronics Inc.**, Rochester, Mich., manufacturers of die-stamped circuits for electrical and electronic applications. Dytronics stockholders have approved the acquisition. Purchase will be made through an exchange of stock. Taylor Fibre will operate Dytronics as a subsidiary at its present location, 115 Main St., Rochester, with its present officers and employees. Plans are also underway to immediately expand production facilities in the Rochester area, improve and modernize production equipment and intensify the company's research and development activities.

Keystone Engineering Co., Los Angeles, has acquired a controlling interest in **Western Arc Welding, Inc.**, of Los Angeles, specialists in precision welding of exotic metals for the defense industry. Western Arc Welding, Inc. will continue to operate independently as a subsidiary company with E. T. Sherrick, former director of engineering, in charge as vice president and general manager.

new facilities

Plans for construction by the **General Electric Co.** of a $3,000,000 laboratory for the study of advanced manufacturing methods has been revealed by H. B. Miller, vice president of manufacturing services. The new laboratory facility will consolidate in one location six manufacturing services components now operating at various locations in Schenectady. Construction of the company-wide facility will begin in early 1961 and is scheduled for completion late the same year. In making the announcement, Miller pointed out that the laboratory will provide the company with many of the tools necessary to maintain leadership while holding down costs. "The answer to foreign competition is not in reducing American living standards, but in improving our productivity and our products," he said. "And that's exactly what laboratories like this are set up to do." Scope of the laboratory's activity will be in the areas of research and development, teaching and counseling and dissemination of data on manufacturing methods. The manufacturing laboratory was established by the company in 1952 and since has been responsible for the development of a variety of advanced concepts in manufacturing. The new structure will contain 170,000 sq ft of floor space. It will house modern offices, laboratory facilities, shops, classrooms and auditorium. Giffels & Rossetti of Detroit are architects for the project.

moves

The Chicago district office and warehouse of the **Socket Screw Div.** of **The Bristol Co.** have moved from 353 E. Ohio St., Chicago, to 2040 N. Hawthorne Ave., Melrose Park, Ill. W. C. VanLeuven, socket screw sales manager, says the new facilities will provide expanded office and warehouse space for improved service to Bristol's Midwestern distributors.

The Heinemann Electric Co., of Trenton, N. J., has announced its relocation in a new and larger plant. The firm is a major producer of circuit breakers, overload relays and time-delay relays used for the protection and control of electrical and electronic equipment. The new plant, located on Brunswick Pike (U. S. Route 1), Trenton, also houses Heinemann's main administrative and sales offices and expanded test facilities.

new activities

A $2,300,000 contract has been awarded **Baldwin-Lima-Hamilton Corp.** for construction of the pressure vessel, pressure vessel liner, and core support for the Atomic Energy Commission's Experimental Gas-Cooled Reactor (EGCR) at Oak Ridge, Tenn. Projected as the nation's first gas-cooled reactor for civilian use, the EGCR is expected to contribute to development of nuclear power which is priced competitively with power produced from conventional fuels. B-L-H will build the pressure vessel, liner and core support —components for the power-generating heart of the reactor—at the 1½ million sq ft plant of its Industrial Equipment Div. at Eddystone, Pa.

Futurmill, Inc., Pontiac, Mich., and its exclusive licensee, **Wesson Co.**, have granted a sub-license to **Wetmore Tool and Engineering Co.** of Los Angeles to manufacture and sell indexable blade milling cutters under Futurmill's milling cutter patents.

awards

Gray Iron Founders' Society, national trade association of the gray iron industry, received national recognition by winning the National Safety Council's 1960 Safety Award. Purpose of the contest is to recognize associations which promote accident prevention among small employers. Basis of the award was the Society's 1959-60 accident prevention program featuring the preparation of safety booklets, a safety leadership publicity campaign and organization of the safety activity in local management executive groups. Presentation of the Council's safety plaque will be made at the Association's 32nd annual meeting in Cincinnati on October 12-14, 1960.

mergers

Joseph A. Snook, president of **Atlas Mineral Products Co.** of Mertztown, Pa., and Murray H. Bennett, president of **Chemical Linings, Inc.**, Watertown, N. Y. have announced merger and a move from 156 Stone St., Watertown, N. Y., to Mertztown, Pa., where the former Chemical Linings will operate as an Atlas Division. Both Atlas and Chemical Linings are now wholly-owned subsidiaries of The Electric Storage Battery Co. of Philadelphia.

An announcement by H. G. Bixby, president of **Ex-Cell-O Corp.**, Detroit, states that **Bryant Computer Products** has become a division of Ex-Cell-O, and that the management, sales, product engineering, research and development activities of this division have moved into a new building at the Ex-Cell-O Technical Center, Walled Lake, Mich.

Concurrent with the recent stockholder-approved combination of Ling-Altec, Inc. and Temco Aircraft Corp., the name of Temco Aircraft Corp. was changed to **Temco Electronics & Mis-**

siles Co. and, as a subsidiary of Ling-Temco Electronics, Inc., it will maintain its present and avidly pursue its projected commitments.

association news

Roy E. Blue, chief product engineer of the Amplex Div. of the Chrysler Corp., has been elected president of the **American Powder Metallurgy Institute.** He succeeds Robert C. Burgess who had served as president since the Institute's founding in November 1959.

At the annual meeting of the governing council of **American Electroplaters' Society, Inc.,** held recently in Los Angeles, Calif., Dr. W. Andrew Wesley of Plainfield, N. J., an executive of The International Nickel Co., was unanimously elected national president for 1960-1961 succeeding Ralph D. Wysong, Studebaker-Packard Corp. The meeting of the delegates of AES's 58 branches in the U. S., Canada and Australia composing the council, climaxed the Society's 47th annual convention.

expansions

James K. Malone, president of **Federal Mfg. & Engineering Corp.,** Garden City, N. Y., announces a third new division as part of the company's expansion program. It will be known as the Design Tool Co. Div. Through a stock arrangement, F.M.E. has acquired the manufacturing and sales rights to the complete product line of the Design Tool Corp., Brooklyn. Under the general managership of Carl Kertesz, the Design Tool Co. Div. will transfer production, sales and service to the F.M.E. Garden City plant.

Burg Tool Mfg. Co., Inc., Gardena, Calif., is expanding its present manufacturing facilities by 31,520 sq ft. The addition will provide new general offices, machine assembly area and also house the Burgmaster Div. that manufactures and distributes the bench model 6-spindle turret drilling & tapping machine. The present office space will be utilized by the sales and engineering departments.

In a move aimed at sharply expanding current production quotas, **The Nesor Alloy Products Co.** has opened a new plant and adjoining sales and administrative facilities at 666 Passaic Avenue, West Caldwell, N. J. The company, which produces fine drawn wire in all ferrous, nonferrous and precious metals, will produce the wire to exacting tolerances with uniform, dependable tempers. Modern facilities for wire, braid, strand ribbon and component parts are also part of the new plant. Metals will include aluminum and alloys, bare and tinned copper, silver-plated copper, brass and alloys, phosphor bronze, lead and solder alloys, monel-nickel, resistance wire, stainless steel, both high and low carbon steel, and copper coated steel. Extreme high purity silver, gold, platinum and their alloys are drawn to 0.0005. The new plant is already in full production.

Progressive Welder and Machine Co., Pontiac, Mich., manufacturer of specialized resistance welding equipment, announces the expansion of their national sales organization. According to William B. Payne, sales manager, a new west coast office has been opened at 5909 Melrose Avenue, Los Angeles 38, Calif.

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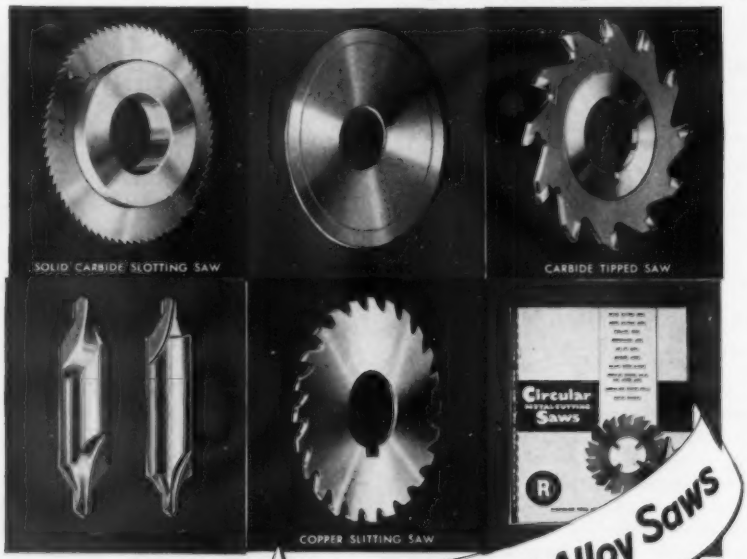

Circoloy Special Alloy Saws

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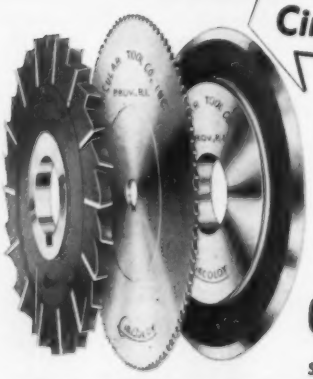

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who's meeting and where

Oct. 6-7. National Association of Corrosion Engineers. Regional meeting. Sheraton-Palace Hotel, San Francisco, Calif.

Oct. 7-16. Italian Machine Tool Builders Assn. Italian machine tool exposition. Milan, Italy. Information available from A. Giaroli, Italian Trade Commissioner, 59 E. Madison St., Suite 1601, Chicago 3, Ill.

Oct. 9-13. The Electrochemical Society, Inc. Sessions on batteries, corrosion, electrodeposition, electrodeposition—electrothermics and metallurgy joint symposium on vapor deposited coatings, electronics—seminconductors, and electrothermics and metallurgy. Shamrock Hotel, Houston, Tex.

Oct. 10-12. National Electronics Conference, Inc. Fifteenth annual meeting. Hotel Sherman, Chicago, Ill.

Oct. 10-14. Pressed Metal Institute. Annual meeting. Shawnee Inn, Shawnee-on-the-Delaware, Pa.

Oct. 11-12. ASTME. Technical seminar on high energy rate forming. Sheraton Towers, Chicago, Ill.

Oct. 12-14. Gray Iron Founders' Society, Inc. Thirty-second annual meeting. Netherlands Hilton Hotel, Cincinnati, Ohio.

Oct. 17-19. ASME, American Society of Lubricating Engineers. Lubrication conference. Statler Hilton Hotel, Boston, Mass.

Oct. 17-21. ASM. Forty-second national metal congress and exposition. Convention halls and Bellevue-Stratford Hotel, Philadelphia, Pa.

Oct. 17-21. National Safety Council. Forty-eighth annual national safety congress. Industrial sessions at Conrad Hilton, Pick-Congress, Sheraton Towers, Morrison and La Salle Hotels, Chicago, Ill.

Oct. 19. Fluid Power Society. First annual meeting. Chicago, Ill. Information available from Barrett Rogers, 5595 N. Hollywood Ave., Milwaukee 17, Wis.

Oct. 19. Society of Plastics Engineers. "Tooling for the Plastics Industry." Hotel Commodore, New York, N. Y.

Oct. 20. National conference on industrial hydraulics. Chicago, Ill.

Oct. 25-27. ASA. Eleventh national conference on standards. Sheraton-Atlantic Hotel. New York, N. Y.

Oct. 26-27. Armour Research Foundation, Illinois Institute of Technology. The 1960 computer applications symposium. Morrison Hotel, Chicago, Ill.

Oct. 27-28. The Galvanizers Committee, American Zinc Institute. Forty-second meeting. Onesto Hotel, Canton, Ohio.

Oct. 31-Nov. 2. National Fluid Power Assn. The 1960 fall meeting. Edgewater Beach Hotel, Chicago, Ill.

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Above: Ellstrom Rectangular Set No. 92-R. Right: Ellstrom Square Set No. 81-SA, with accessories.

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THE BASIC PLAN

Pays cash to you or your beneficiary, with choice of amount from $10,000 to $250,000 in the event of accidental Death; Dismemberment (as scheduled); Permanent Total Disablement; Disappearance or Exposure as provided in the policy.

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The annual rate for the Basic Plan is 90c per $1000. For Blanket Medical Expense coverage it is $12.00 for the first $1000 and $6.00 for each additional $1000. For Weekly Income the premium is 85c per $5.00 benefit.

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	$ 100 Weekly Income	17.00
	Annual Cost	$ 74.00
#3	$ 25,000 AD&D	$ 22.50
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INDICATE COVERAGES AND AMOUNTS DESIRED:

- ☐ ACCIDENTAL DEATH DISMEMBERMENT, etc. AMOUNT $ _____ PREMIUM $ _____
- ☐ BLANKET MEDICAL EXPENSE AMOUNT $ _____ PREMIUM $ _____
- ☐ WEEKLY INDEMNITY AMOUNT $ _____ PREMIUM $ _____

TOTAL PREMIUM $ _____

DATE _____ MEMBER'S SIGNATURE _____

WIFE ENROLLMENT (If Desired)

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- ☐ ACCIDENTAL DEATH DISMENBERMENT AMOUNT $ _____ PREMIUM $ _____
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TOTAL PREMIUM $ _____

DATE _____ WIFE'S SIGNATURE _____

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.....reader's viewpoints

. . . pressure-coolant reaming

To the Editor:

In editing the manuscript of my ASTME technical paper "Pressure-Coolant Drills and Reamers for Precision Hole Production" you have inserted "gun reaming" for "pressure-coolant reaming." This paper appeared in the July 1960 issue of THE TOOL ENGINEER under the title "Putting Gun Reamers To Work."

Actually there is a great deal of difference between gun reamers and pressure-coolant reamers. Gun reamers are used only in the manufacture of long holes in gun barrels. They are a pull type tool. Normally they use low-pressure coolant directed down through the tool into a pair of cross holes.

By contrast, pressure-coolant reamers were developed for the specific purpose of sizing holes of any length. In fact, most applications are in machining holes of comparatively short length. The tool rotates as it works and it uses high-pressure coolant directed from a hole in the body into the bottom of each flute.

Today, the use of the term "gun reamer" is rather archaic except in the production of gun barrels. Therefore, the term "pressure-coolant reamer" was selected to provide industry with a generic name for the process.

Herbert V. Gregg
Chief Engineer
Star Cutter Co.

. . . grinding

To the Editor:

In his article, "Calculating Grinding Wheel Wear and Production," THE TOOL ENGINEER, June 15, 1960, Prof. Uniechowski implies that wheel wear and production are unaffected by the type of work material, wheel specifications or grinding fluid as long as average grit spacing within the wheel remains the same. He has not stated, as did the references he cites, that the equations apply only to the cylindrical grinding of mild steel and that the numerical constant in Equations 3 and 5 applies only to a particular wheel specification.

This constant was obtained from grinding tests conducted in connection with Chapman's paper, published in 1920. Other constants were obtained when other wheels were used. Because wheels, machines and fluids have improved significantly since 1920, reduced wheel wear can be expected for cuts comparable to those made by Chapman. Thus the constants used—satisfactory in their day—are unlikely to be correct for present-day usage.

In addition, the thickness of actual grinding chips which is the same as the maximum depth of chip G is not smaller than the wave length of light, as indicated by the two numerical examples, but is likely to be an order of magnitude greater for ordinary cylindrical grinding conditions. The calculated values are much too small because they are based on an erroneous assumption concerning grain spacing. This spacing is far greater than indicated by calculations based on grain size, and chip thickness is greater in the same proportion.

It is well to point out that the original grain-depth-of-cut theory, upon which this article is based, describes only the geometrical aspects of grinding without considering other factors which may affect the operation. For example, it predicts that wheel wear increases with a decrease in wheel speed. Actually the opposite can occur in the grinding of materials such as high-vanadium tool steel, austenitic stainless steel, titanium and zirconium.

In cases where this theory is applicable—as in the grinding of mild steel—it can be used quantitatively only and it depends on exact values of certain empirical constants. These are rarely available. Its principal value is its provision of a qualitative explanation of what happens when feeds, speeds and diameters are changed.

L. P. Tarasov
Research and Development
Norton Co.

The formulas on grinding wheel wear in my manuscript are based on the latest information generally available. Chapman's work from 1920 is quoted extensively in the Twelfth Edition of *Kent's Mechanical Engineers Handbook, Design and Production Volume.* Until now we have had no reason to question the validity of the constants. Dr. Tarosov's comments are appreciated and valuable.

S. R. Uniechowski
Associate Professor
Engineering Mechanics
University of Detroit

. . . on creativity

To the Editor:

Mr. Ackerman's commencement remarks ("Discontented Engineers Most Creative," Page 55, July issue) might better have been addressed to top management, which is too often content with contentment. . . .

R. M. White
Borger, Tex.

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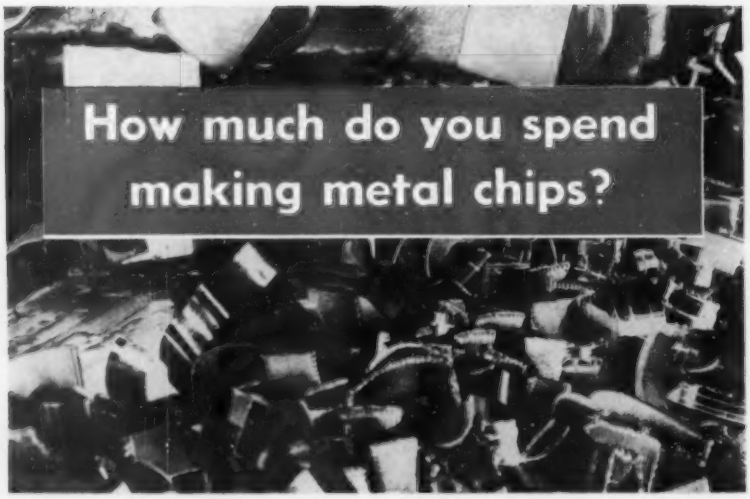

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CHARACTERISTICS OF ENGINEERS AND SCIENTISTS—*by Lee E. Danielson. Published by The University of Michigan, Bureau of Industrial Relations, Ann Arbor, Mich. Price $4. 136 pages.*

Although the engineering mind is trained for analytical thinking, its reaction to problems in "human equations" usually follows conventional—and sometimes erratic—patterns. For example most engineers are creative, but many find it difficult to confine their creativity to problems within their own fields. Some, if not all, are highly individualistic, a trait necessary for original thinking, but one which can spill over into personality clashes. These factors often combine to make the engineer a highly disruptive factor in his company.

This book analyzes the employability of engineers and scientists and the problems they create. Its purposes in doing so are to identify and publicize some of the more successful managerial policies used in promoting engineering and scientific productivity. Engineers will find this book highly interesting for several reasons. One is that it will provide them with some edifying and often incisive glimpses into management's view of their profession. Another is that it may assist them in taking a more realistic view of their own careers.

BASIC GRAPHICAL KINEMATICS—*by Harold B. Kepler. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. Price $6. 314 pages.*

Designed to help the reader master the fundamentals of kinematics, this book utilizes the graphical approach to the subject. It keeps analytical work to a minimum and presents explanations and derivations graphically where possible. This approach enables the reader to understand the material without a knowledge of calculus.

All basic topics are covered, including displacements, velocities, accelerations, cams, gears, chains and belts. Separate chapters give the reader an insight into drafting techniques required in graphical solution of kinematics.

CAST BRONZE BEARING DESIGN MANUAL—*by Harry C. Rippel. Published by the Cast Bronze Bearing Institute, Inc., 1604 Chicago Ave., Evanston, Ill. Price $2. 72 pages.*

Theoretical and practical aspects of bearing design are treated. Basic topics include types and methods of lubrication, bearing bronze selection, grooving specifications, and fabrication and assembly of bearings.

In treating this subject, the author has made extensive use of graphs and charts to provide fast, accurate answers to problems of bearing design. He has not neglected the mathematics essential to design-sheet calculations. In some cases examples of actual design problems are given and solved in logical step-by-step procedures.

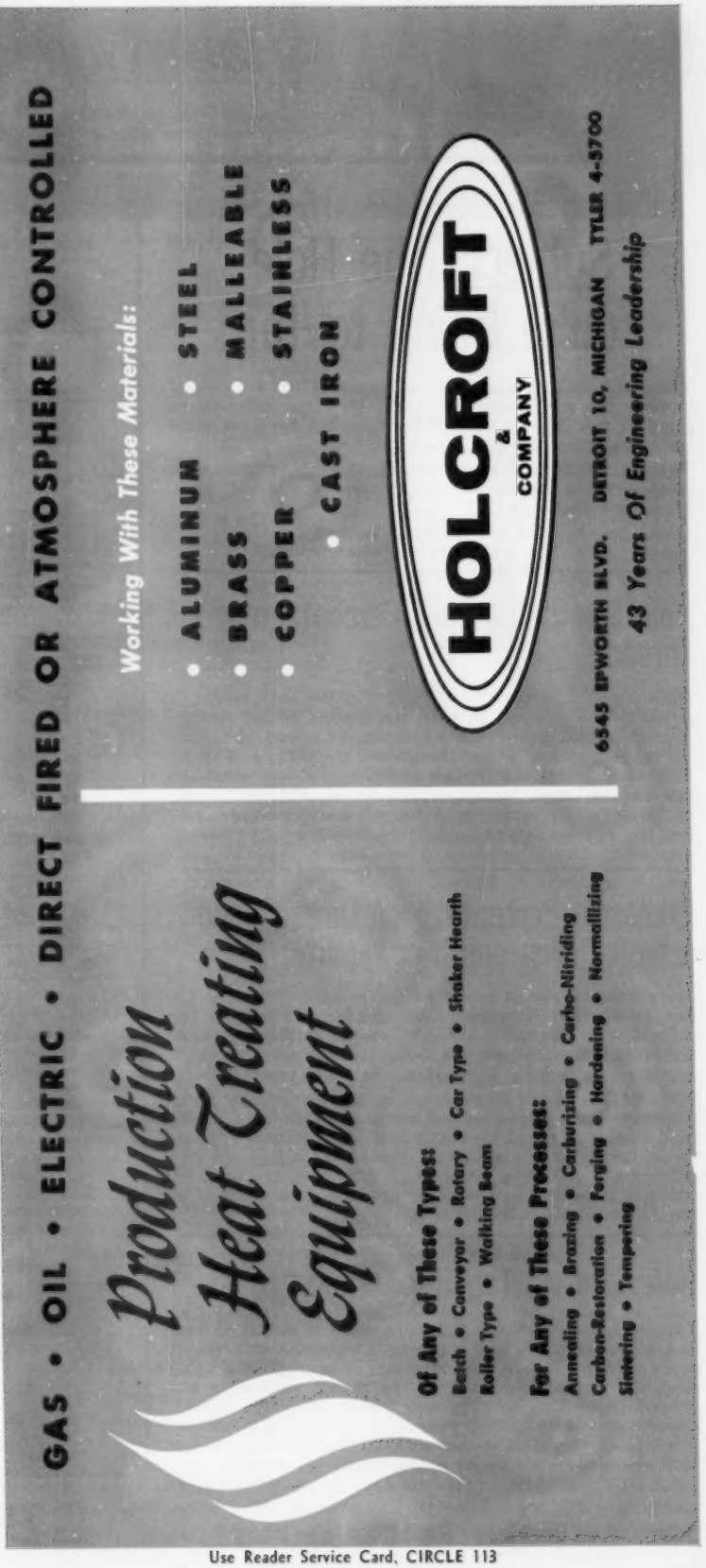
The initial publishing venture of the newly formed Cast Bronze Bearing Institute, this manual will prove useful to tool and manufacturing engineers whose work involves problems of bearings and lubrication.

DIRECT CONVERSION OF HEAT TO ELECTRICITY—*By Joseph Kaye and John A. Welsh. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.*

Because of its potential in many different applications, the subject of thermoelectric conversion is receiving much attention. Originally noted by Thomas Johann Seebeck in 1821, the discovery lay dormant for over 100 years. The appeal of direct thermoelectric conversion is manifold: there are no moving parts (except of course, atomic particles and ions); it can use waste heat sources for generating electricity, as for example rocket exhausts; and it ultimately may become considerably more efficient than existing electromechanical conversion methods.

The field is new, not much experience is yet available. For these reasons a program was offered at MIT. The 23 papers presented by some 30 authors comprize this valuable reference book. Four types of generators are discussed: thermionic engines (vacuum tube and gaseous tube), thermoelectric engines (working on the thermocouple principle), magnetohydrodynamic conversion (where positive and negative charges in a gas are separated) and fuel cells (separation of positive and negative charges during chemical reaction.)

Seebeck's first thermoelectric generator was estimated to have an efficiency of 3 percent. Theoretically designed converters have efficiencies of around 33 percent. As these levels are approached and improved upon, the principle will see practical application in space platforms, household appliances, heating and air conditioning, large power stations and portable power sources.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Carbon-Restoration • Forging • Hardening • Normallizing
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BATH *Tap'n Gage* TIMES

A series of technical discussions that will be helpful in getting better results from tapping and gaging operations

Vol. 1 No. 1

Subject: The Hole You're Going to Tap:

There are many things affecting successful and economical tapping but none more important than the hole you're going to tap. This is a big subject — but here are some basic points to remember which can help you.

Tapping torque and chip removal, or chip volume, in a large measure determine tap life and production costs. Major influences are:

1. The hole size before tapping
2. The hole condition before tapping

Hole Size determines Percentage of Thread

Definition: "A percentage proportion of the basic height of thread:" The smaller the hole, the greater the percentage of thread. The greater the percentage of thread, the more the tapping torque — and the greater the volume of chips. This means increased friction and temperatures which cut tap life and require slower tapping speeds. Friction caused by chips packing in the tap flutes is a severe problem, particularly in deep hole tapping. These troubles can be largely avoided by careful selection of hole size.

Excessive Percentage of Thread — not a factor in strength or quality

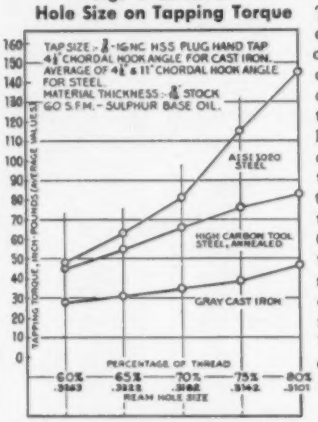
Percentage of thread specifications in Screw Threads for Federal Services Handbook H28, runs from about 53% for a No. 0-80 to about 74% on ½" diameter and larger. These percentages are adequate for the majority of work although special consideration is necessary in some cases such as stud fits.

Extensive tests show that the static strength for a length of engagement equal to a standard nut thickness reaches its maximum at 60 percent of thread. Therefore, greater percentages of thread cannot be justified on the basis of strength alone and can only be obtained at a sacrifice in tap life and efficiency.

Hole Size vs. Tapping Torque

Tapping torque increases with percentage of thread — but at a much faster rate than is generally supposed. In a recent series of torque tests it was found that in tapping AISI 1020 steel, the torque doubled when the thread percentage increased from 60% to 72% and tripled when the thread percentage was 80%. The increase was not so pronounced in annealed tool steel or cast iron, but the tests show that hole size is always a major consideration. (See fig. 1.)

Fig. 1 Effect of Hole Size on Tapping Torque


TAP SIZE - ½-16 NC H55 PLUG HAND TAP
4½° CHORDAL HOOK ANGLE FOR CAST IRON.
AVERAGE OF 4½° & 11° CHORDAL HOOK ANGLE FOR STEEL.
MATERIAL THICKNESS - ⅜ STOCK
60 S.F.M. - SULPHUR BASE OIL.
TAPPING TORQUE - INCH POUNDS (KEYSEAT VALUES)
AISI 1020 STEEL
HIGH CARBON TOOL STEEL, ANNEALED
GRAY CAST IRON
PERCENTAGE OF THREAD
60% .3143
65% .3122
70% .3102
75% .3142
80% .3101
REAM HOLE SIZE

The reason for these sharp increases in torque with increases in percentage of thread can be found in the volume of chip removal. On a basic thread form a 50% thread height represents the removal of only 31.25% of the basic thread area, while an increase to 75% thread height increases the area to be removed to 60.9%—or, practically double the first amount. It can be seen that even relatively small decreases in hole size can materially affect performance by increasing torque due to chip removal and disposal. (See fig. 2.)

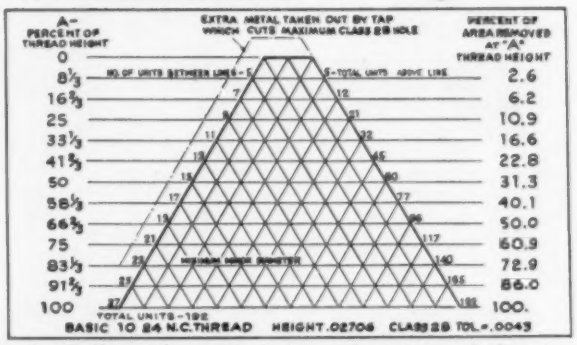


Fig. 2 Chip Volume in relation to Percentage of Thread

Hole Condition

In addition to hole size, great care should be taken so that holes will be properly prepared for tapping. The tap will have a tendency to follow the configuration and direction of the hole and if these are not reasonably accurate in relation to the tap axis and diameter, tap breakage, and holes that will not satisfy gages, will result. Conditions to be avoided are bell mouth or tapered holes, bent or crooked holes, out of round, torn or scored holes, holes with burrs, and holes with work hardened areas.

For a more detailed discussion of this subject (and particularly information on the diameter of holes which produce various percentages of threads) — fill out and mail attached coupon with 25¢ for technical brochure "Drilled Holes for Tapping" published by the Metal Cutting Tool Institute.

Clip and mail coupon NOW!

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Trade Literature

for free booklets and catalogs—use request card, page 169

USE OF THE BENDIX G-15 computer in the mechanical engineering field is reviewed in a new application report brochure. Computer Div., Bendix Corp. **(Circle 401)** . . . Ninety-six page catalog 1960 shows a complete line of lathes, milling machines, shapers, drill presses and pedestal grinders with tools, attachments and accessories. South Bend Lathe Co. **(Circle 402)** . . . Catalog 160 provides 16 illustrated pages of all styles and specifications of machining heads and catalog 260 contains 28 pages of information on feed tables and machine beds. Master Mfg. Co. **(Circle 403 and/or 404)** . . . The May-June issue of *Technical Aids for Small Manufacturers* is devoted to an article on "Pointers on Dimensions and Tolerances," by Joseph deFeher. Small Business Administration. **(Circle 405)** . . . Details of the scope of the company's operations are presented in a 32-page, illustrated brochure. Buhr Machine Tool Co. **(Circle 406)** . . . An eight-page, illustrated case history is titled, "Speeding the Reproduction Facility for Baldwin-Lima-Hamilton." Anken Film Co. **(Circle 407)** . . . Heavy duty pillow blocks with self-aligning spherical roller bearings in split housings are described and illustrated in a 20-page brochure. The Torrington Co. **(Circle 408)** . . . Thirty-two page catalog No. 4 gives information on high-speed steel end mills, keyseat cutters, combination drills and countersinks, reamers and counterbores. Fastcut Tool Co. **(Circle 409)**

Automation & Mechanization

Illustrated, 12-page booklet contains general information on numerically controlled machine tools and describes three specific types of machines currently in use. Ex-Cell-O Corp. **(Circle 410)** . . . A series of reciprocating bars designed for materials handling are described in a six-page folder. Conveyor Corp. **(Circle 411)** . . . A new approach to automatic assembly is described in eight-page catalog No. 602. Ferguson Machine Corp. **(Circle 412)** . . . A numerical control system with modular design is described in an eight-page brochure. Diehl Mfg. Co. **(Circle 413)** . . . Electromagnetic pickups are described in bulletin CMP-50, along with a selection guide chart, output curves and block diagrams. Electro Products Laboratories. **(Circle 414)**

Bearings

New concepts for applying thin-sectioned large-bore ball bearings to equipment designs are presented in a 28-page booklet. The Kaydon Engineering Corp. **(Circle 415)**

Boring, Drilling & Tapping

Eighteen standard cartridge type toolholders that comprise the company's system for assembling a variety of single or combination boring, facing or recessing tools are described in bulletin No. C-660. Wesson Co. **(Circle 416)** . . . Bulletin R-3 describes and illustrates the company's facilities for repair and renewal of grinding, boring, drilling and milling spindles. Pope Machinery Corp. **(Circle 417)** . . . Circle T-15 tool bits are covered in a new catalog section. Firth Sterling Inc. **(Circle 418)** . . . Twenty-eight page catalog No. 2 describes six types of multiple spindle drillheads. Thriftmaster Products Corp. **(Circle 419)** . . . Bulletin S-21 describes design, construction, and operating features of an opposed-head precision boring machine. Pope Machinery Corp. **(Circle 420)** . . . Bulletin No. MD 1596 presents a line of custom engineered multiple drilling machines. Pistorius Machine Co. **(Circle 421)** . . . An eight-page brochure describes the operating features of Series H and Series K turret indexing machine chassis. Swanson-Erie Corp. **(Circle 422)** . . . Bulletin 854 provides four pages of illustrations and descriptions of hand and power-revolving index tables. The Cincinnati Gilbert Machine Tool Co. **(Circle 423)**

Cleaning, Painting & Plating

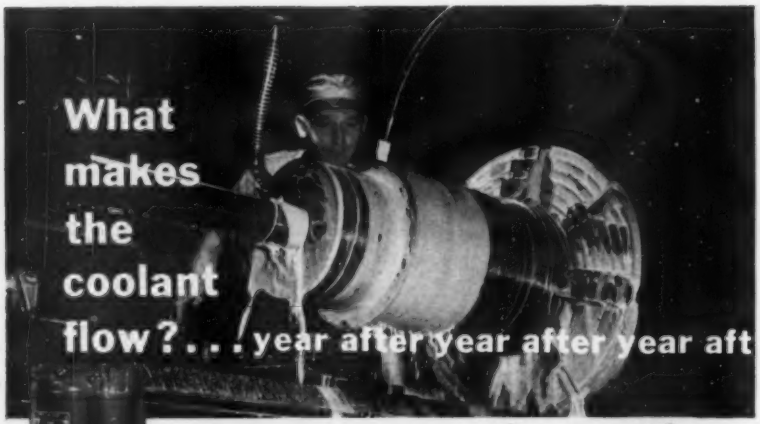
Bulletin 60-1 provides a basic explanation of how ultrasonics works, what it can do to cut time and labor costs, and a guide to the selection of tank and generator sizes for various jobs. Powertron Ultrasonics Corp. **(Circle 424)** . . . Literature provides information on dual-purpose core knock-out and blast cleaning for the foundry industry. Wheelabrator Corp. **(Circle 425)**

Electric Motors, Controls & Drives

Eight-page bulletin 21103, "Five Simple Steps to the Selection of Timing Belt Drives," gives a method involving a minimum of mathematics for the selection of a drive to fit any application. T. B. Wood's Sons Co. **(Circle 426)** . . . Catalog SW-1 is a 24-page explanation of how the company's wedge drive reduces drive size and provides cost reductions without loss in hp capacity. Maurey Mfg. Corp. **(Circle 427)** . . . GED-3909A is a pocket-size card that provides quick reference to frame sizes 182 through 445U and book prices for a-c motors from ¾ to 125 hp. General Electric Co. **(Circle 428)** . . . Booklet 60 provides 56 pages of descriptions, ratings and prices for manual and magnetic starters, drum controllers, pressure, foot and limit switches. Furnas Electric Co. **(Circle 429)** . . . Information on a high-performance speed variator, which uses Thyratron tubes to convert a-c to d-c power, is contained in bulletin GEA-7019. General Electric Co. **(Circle 430)** . . . Bulletin 111 covers syncro-range-drives, ranging in size from 2 to 15 hp, and providing adjustable speed of synchronous induction motors running in exact synchronism over a wide range of speed. The Louis Allis Co. **(Circle 431)** . . . Technical information on shaftmounted geared speed reducers is presented in brochure No. F-2203. U. S. Electrical Motors Inc. **(Circle 432)**

Fastening & Joining

Information on epoxy adhesives, their application, cure times and physical properties is presented in an adhesives properties chart suitable for desk or wall mounting. Furane Plastics Inc. **(Circle 433)** . . . "Master Power Portable Air Tools for Screwdriving and Nutsetting" are described in detail in catalog N. S. 60. Master Power Corp. **(Circle 434)** . . . Fifty welding training aids, including books, charts and films, are listed and described in a six-page



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Trade Literature

folder. Hobart Welding School. **(Circle 435)** . . . Latest information on socket head cap screws is detailed in a new brochure. Standard Fasteners, Standard Screw Co. **(Circle 436)** . . . A 27-page pictorial report features equipment applications and descriptions. Sciaky Bros., Inc. **(Circle 437)** . . . Form ADPC 26A covers, with illustrations, the uses of carbon dioxide in the welding industry. Pure Carbonic Co., Div. of Air Reduction Co., Inc. **(Circle 438)**

Finishing & Grinding

Eight-page bulletin No. 870-60 describes a line of gear finishers and covers three methods of shaving, with illustrations of how setups are simplified. Michigan Tool Co. **(Circle 439)** . . . Bulletin No. 35B60 describes an hydraulic surface grinder. Covel Mfg. Co. **(Circle 440)**

Fluid Power

Four-page bulletin provides complete data on air and hydraulic power cylinders. Miller Fluid Power Div., Flick-Reedy Corp. **(Circle 441)** . . . Form 601-10M presents a line of pneumatic or hydraulic oscillating motors with instant full torque. Roto-Tork Mfg. Co. **(Circle 442)** . . . Sixteen page bulletin No. 260 covers C4H Series 2000-3000 psi interchangeable hydraulic cylinders in bore sizes of 1⅛ to 12 inches and 17 mountings. The Sheffer Corp. **(Circle 443)** . . . Available by request on company letterhead, a 24-page catalog presents a complete line of cylinders, drill units and valves and introduces a new interchangeable cylinder for air and oil service. Alkon Products Corp. **(Circle 444)**

Gearmaking

A company letterhead request, which specifies title or job classification, will secure a 246-page gear and speed reducer catalog, fully illustrated, and containing complete specifications of company products. The Ohio Gear Co. **(Circle 445)**

Heat-Treating

Vol. 1, No. 7. *High Frequency Heating Review* presents applications, metallurgical aspects, shop hints and new induction heating equipment. Lepel High Frequency Laboratories, Inc. **(Circle 446)** . . . Bulletin SEC-10 presents a pit type recirculating furnace. Sunbeam Equipment Corp. **(Circle 447)**

Inspection & Measurement

"Sources of Measurement Error" is a wall chart that can be applied to all gaging systems. Cleveland Instrument

Co. **(Circle 448)** . . . Catalog G-100 is a four-page, illustrated brochure describing systems and components available for continuous indicating and monitoring of minute changes in dimensions for control useage. Measurement Control Devices. **(Circle 449)** . . . A "Questions and Answers" brochure is a cross-indexed classification containing technical answers to questions about granite surface plates. Rahn Granite Surtrol Devices. **(Circle 450)** . . . A 40-page catalog illustrates, describes and prices a complete line of gages. Cadillac Gage Co. **(Circle 451)**

Lubricants & Coolants

The theory and practice of lubrication by solids are the primary subjects of bulletin 124, a 24-page description of the major advantages of molybdenum disulfide solid lubricants. The Alpha-Molykote Corp. **(Circle 452)** . . . A two-page data sheet describes the applications and specifications of filtering equipment for machine tools. Industrial Filters Co. **(Circle 453)**

Materials

"Infab for Producing Space Age Metals" is the title of a 12-page brochure describing a process developed in cooperation with the Department of the Navy, Bureau of Naval Weapons. Refractomet Div., Universal-Cyclops Steel Corp. **(Circle 454)** . . . A 12-page booklet gives details on "Carmet Cemented Carbides in Design for Wear Resistance." Carmet Div., Allegheny Ludlum Steel Corp. **(Circle 455)** . . . A four-page folder entitled "Steel Selection for Machine Parts Made Easy for R & D Men" presents steel selection ideas. La Salle Steel Co. **(Circle 456)** . . . "Facts About Plastics" is a six-page, pocket-sized booklet comparing properties and industrial applications of 13 major plastic families in common industrial use. Cadillac & Chemical Co. **(Circle 457)** . . . Bulletin No. 47 provides specifications for five different types of the manufacturer's nodular iron. Meehanite Metal Corp. **(Circle 458)** . . . A 28-page booklet, edited and reprinted, describes Hastelloy alloy X. Haynes Stellite Co. **(Circle 459)** . . . Technical data on properties of glass fibre are a feature of four-page bulletin TD-100. Pall Corp. **(Circle 460)** . . . A technical bulletin discusses spectrographic metallurgical control and its application to high alloy steel castings. Lebanon Steel Foundry. **(Circle 461)**

Materials Handling

Service manual No. 10756 includes complete instructions, parts lists and tool

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The new FRINGECOUNT micrometer opens up a whole new dimension in gaging. With this unique instrument, industrial organizations can now make absolute dimensional measurements to an accuracy of one-millionth of an inch under properly controlled conditions. Simple to operate, the FRINGECOUNT can be mastered quickly by industrial gage personnel . . . does not require trained physicists for effective results.

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Trade Literature

diagrams for four lightweight air hoists. Thor Power Tool Co. **(Circle 462)** . . . Repair and modernization of lifting magnets is described in booklet B-7757. Westinghouse Electric Corp. **(Circle 462)**

Milling

"The V.M.U. System of Milling" is a 24-page listing of nearly 500 throwaway insert milling cutter styles and sizes. Valenite Metals. **(Circle 463)** . . . Illustrated data sheet describes hand-revolving tables for use with horizontal boring mills and milling planers. The Cincinnati Gilbert Machine Tool Co. **(Circle 464)**

An eight-page illustrated catalog describes sheet polishing mills for finishing metal sheets, plates and coils. Acme Mfg. Co. **(Circle 465)**

Pressworking

An eight-page catalog provides illustrations and specifications on a line of automatic presses ranging from 5 to 200 tons. Havir Mfg. Co. **(Circle 466)** . . . Fifty-page, revised catalog No. 2023-B covers mechanical press brakes and machines from 160 to 1250 tons, mid-stroke capacity. The Cleveland Crane & Engineering Co. **(Circle 467)**

Catalog A illustrates and describes a complete line of units for punching. Punch Products Corp. **(Circle 468)**

Sawing & Shearing

A specification sheet details the new Lenox Master-Band alloy steel bandsaw blade and lists some of the standard and automatic cutoff machines on which the blade can be used. American Saw & Mfg. Co. **(Circle 469)** . . . Special cutting tools are listed and illustrated in a 45-page catalog. F & D Tool Co. **(Circle 470)**

Precision Spindles & Heads

Pocket size, 36-page bulletin S-18 illustrates and describes more than 60 different types of spindles, spindles arranged for electrolytic grinding and two new boring machines. Pope Machinery Corp. **(Circle 471)**

Tool Steels

Eight-page pamphlet covers UHB 19-VA, a water hardening vanadium alloyed tool steel developed for the cold-heading industry. Uddeholm Company of America. **(Circle 472)**

Thomas J. Kelly has been promoted to the newly-created post of assistant director-international services for Raytheon Co. For the past six years he has served in various management capacities in Raytheon's international operations. The new position has been established as part of Raytheon's expanded worldwide activities. Kelly will also administer a centralized export service.

The appointment of Roy D. Wilson as general manager of J. F. Stokes Co. of Canada, Ltd., subsidiary of F. J. Stokes Corp., Philadelphia, has been announced. Wilson, sales engineer for Stokes of Canada since 1958, was previously a design engineer for Purolator Products (Canada), Ltd. Prior to that he was an industrial engineer for Gair Co. (Canada), Ltd.

Men at Work

Detroit Controls Div. of American-Standard has named Ted G. Breitag manager of manufacturing engineering at the headquarters plant. Breitag, who has been a management consultant since January, 1958, formerly was a plant manager with Schieber Mfg. Co. Earlier he had been with Ford Motor Co. and Detroit Harvester Co., now the Dura Corp.

GUY J. COFFEY, president of the Chicago Pneumatic Tool Co., has announced the appointment of JOHN KACMARIK to the position of general manager of the company's plant at Franklin, Pa. Kacmarik will succeed H. E. MOORE, who is retiring after 41 years with the company. The appointment was effective September 1, 1960. Moore will remain at Franklin in a consulting capacity until December 31, 1960. Kacmarik will be responsible for all activities at the Franklin plant, which is the company's engineering and production center for air and gas compressors; diesel, gas and dual fuel engines; and Reichdrill drilling rigs.

JOHN J. MORRISSEY has been named manager of Dana Corp.'s Marion, Ind. Div. Since 1958 he has been vice president and general manager of General Drop Forge Corp., wholly-owned Dana subsidiary in Buffalo, N. Y. Prior to joining General, Morrissey was with Taylor Pipe and Forge Works, Cicero, Ill.; Ford Motor Co.'s aircraft engine plant, at Chicago; and Wyman-Gordon Co., Harvey, Ill.

Ira Kamen, president of newly reorganized Portland Industries of South Portland, Me., has announced the promotion of Claude Tribert to the vice presidency of the firm. Tribert is a specialist in the use of machinery required for manufacturing mechanisms common to the sonar, radar and nuclear fields to which the company's new effort is being directed.

A major step in the comeback operation of Vinco Corp., Detroit, Mich., was the appointment of ALLISTAIR DUNN as executive vice president. Dunn was formerly director of manufacturing for the Ohio Injector Co.

WILLIAM E. VOGEL, formerly at Dana Corp.'s wholly-owned subsidiary, Atlas Drop Forge Co., Lansing, Mich., has been named chief engineer-manufacturing research and development of the parent company. Vogel, whose headquarters will be with the Dana staff in Toledo, will have responsibility for the design and development of new and different machinery, equipment and processes, working in conjunction with the company's 12 manufacturing divisions and wholly-owned subsidiaries. Prior to joining the Atlas organization several years ago, Vogel held posts as chief engineer, master mechanic, sales manager, and manager of several tooling shops in Detroit, Mich.

Samuel E. MacArthur has been promoted to the position of executive assistant to the president and treasurer of Federal-Mogul-Bower Bearings, Inc., with direct responsibility for three of the company's seven divisions. In his new capacity, MacArthur will supervise operations of the National Seal, Arrowhead and Microtech divisions and will continue as treasurer and a member of the board of directors.

Men at Work

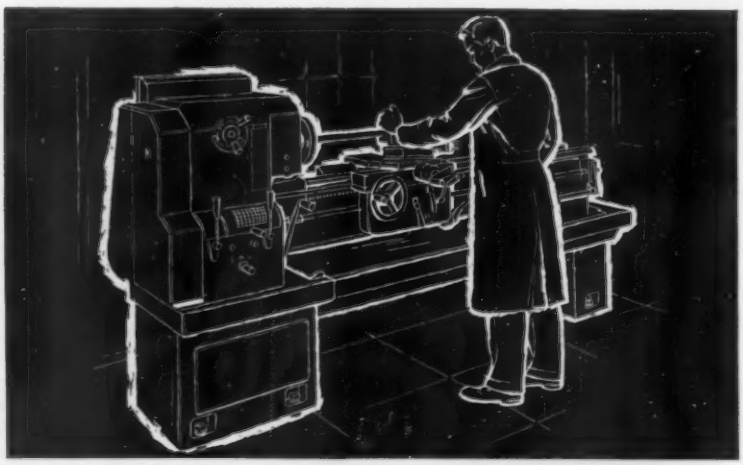
NELSON R. DROULARD of Gwynedd Valley, Pa., formerly research and development director of Budd Co.'s automotive division, has been named technical director of mechanical and nuclear engineering at Franklin Institute Laboratories, Philadelphia. He succeeds FRANCIS L. JACKSON who, in January, became assistant director of the Laboratories. Droulard will direct three Laboratories' branches; engineering mechanics, friction and lubrication, and heat transfer and fluid flow.

I. JOHN BILLERA has been elected executive vice president-operations of U. S. Industries, Inc., in a new alignment of executive responsibilities announced by JOHN I. SNYDER, JR., chairman of the board and president. Billera was previously senior vice president of the company. In the new structure, he will be directly responsible to the chairman of the board and president for the operations of USI's thirteen divisions and subsidiaries. In turn, the vice presidents in charge of operating groups of the company's divisions and subsidiaries will report to Billera.

Leo F. Brown has joined Huck Mfg. Co. as vice president, manufacturing. Among the positions he has held are plant manager with Houdaille-Hershey and General Electric's Air Conditioning Div.; works manager for Graham-Paige and National Electric Products Corp.; and vice president, manufacturing, with Allied Products Corp. Prior to joining Huck, Brown was works manager for Cleveland Pneumatic Industries.

JOHN B. HOLLAND, of Birmingham, Mich., has been appointed automotive division manager of Oakite Products, Inc., manufacturers of specialized chemicals for metal cleaning and surface treatment. Holland comes to Oakite after thirteen years with the Ford Motor Co., where he was production engineer, and four years with General Motors.

Farrel-Birmingham Co., Inc., Watson-Stillman Press Div., Rochester, N.Y., has announced the appointment of R. John Hess as manager of metalworking equipment. He will direct the sale of the company's line of Farrel-Watson-Stillman extrusion, metalworking and general hydraulic equipment. Hess formerly was with Lake Erie Engineering Co., Elmes Engineering Works, Div. of American Steel Foundries, and the Madison Kipp Corp.



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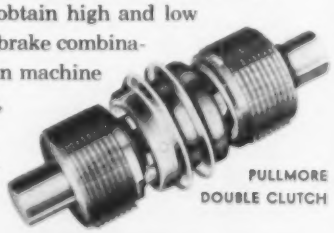

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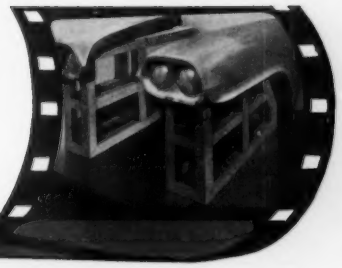
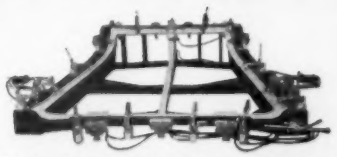


SAVED—$7,500 IN COST, 6 WEEKS IN DELIVERY!



This hood welding fixture is a combination of steel base casting with a surfacing of Ren plastics. Prior to the application of epoxy resin, this fixture was tooled in steel at a cost of approximately $10,000 in 8 weeks. Today's cost in plastic—under $2,500; delivery in 2 weeks!

SAVED—$7,000 IN COST
6 WEEKS IN DELIVERY!

This hydroform die for an aircraft application is a mass casting constructed from a plaster mold. Originally quoted in steel at $10,000, 8 weeks delivery. Using Ren plastics, this die was fabricated in 10 days at less than $3,000!

SAVED—$4,000 IN COST,
2 WEEKS IN DELIVERY!

This mass casting, backed up by sand and gravel, is a form block for the rear roof of a bus. Patterned from a plaster mold, this casting was produced for $2,450—at a savings of $4,000 over conventional methods!

SAVED—$15,500 IN
COST, 6 WEEKS
IN DELIVERY!

This fixture is designed to check an overall front end automotive alignment. Completely fabricated of Ren epoxy laminating materials, glass, cloth and tubing, this fixture costs approximately $2,500 and was built in eight weeks. Former cost, using conventional methods $18,000; delivery in 3 to 4 months!

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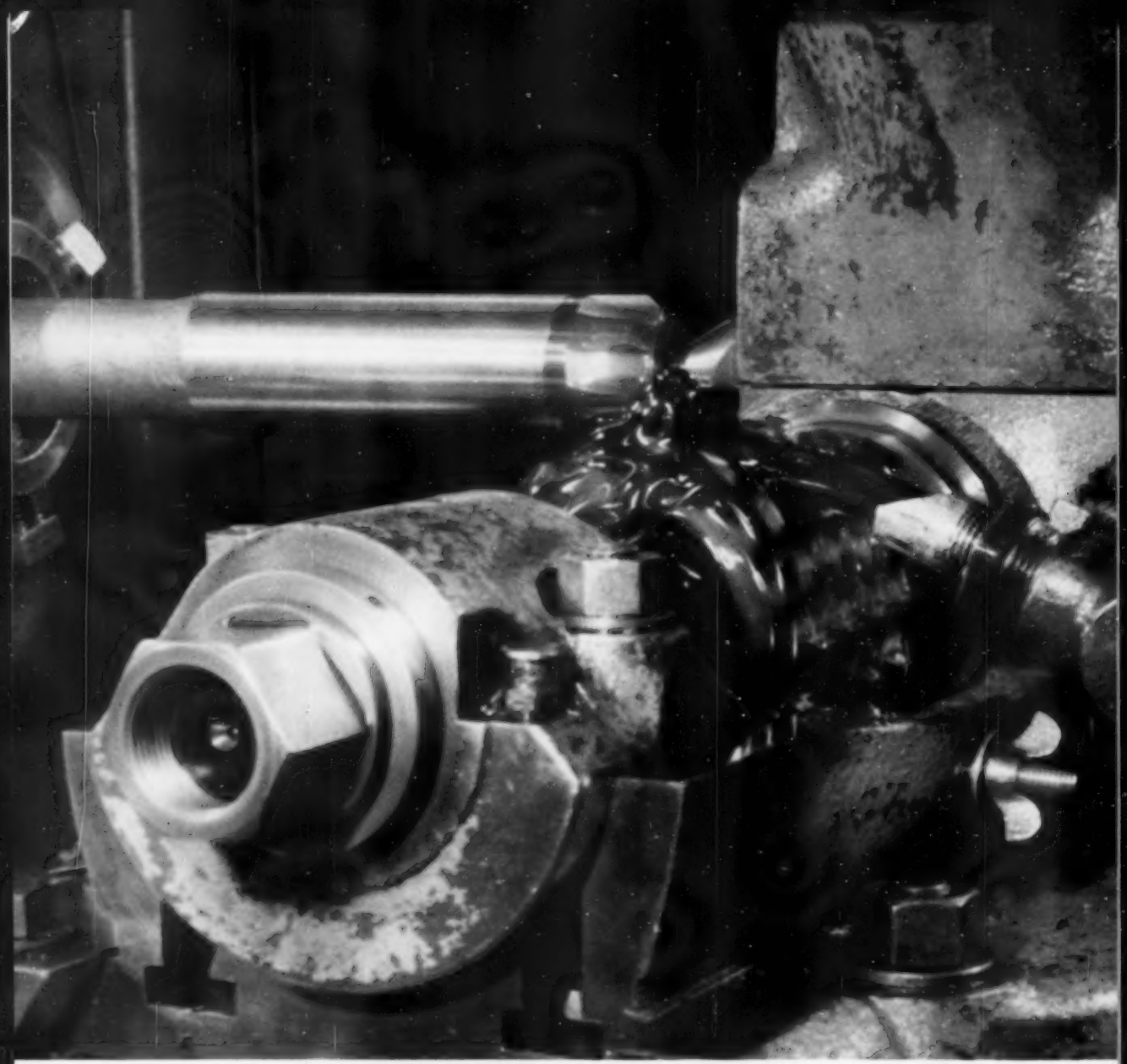

Baker Industrial Trucks switches to Gulfcut® 21C

GULF MAKES THINGS

After a series of comparative cutting oil tests, Otis Elevator Company, Baker Industrial Trucks Division, Cleveland, switched to Gulfcut 21C oil for hobbing their spline shafts, gears, axles, and other drive components. Here's why.

"Tests were carried out under actual work conditions," explains Plant General Manager Eugene Caldwell. "In one test, the workpiece was a 42-tooth spur gear forging of SAE 4142 steel, heat treated to Rc 20-27 hardness and cut on a Barber-Colman gear hobber. The oil we had been using gave us 10 to 12 pieces per hob shift. With Gulfcut 21C, we got 22 pieces.

"In another test, we hobbed Rc 23-34 steel spur gears on a Fellows machine. With our old cutting oil, we used to finish 10 to 12 gears per hob shift. With Gulfcut 21C we finished 20 pieces before regrinding."

Other production tests resulted in similar improvements. Says Mr. Caldwell: "By switching to Gulfcut 21C oil for these applications we've doubled tool life while maintaining close tolerances and fine finishes."

Mr. E. Caldwell, Plant Manager for Otis Elevator Company, Baker Industrial Trucks Division, Cleveland, explains Baker quality points to Thomas F. Irving, Gulf Sales Engineer.

Splines being cut for a Baker lift truck axle. Cutting oil is Gulfcut 21C.

oil, doubles tool life . . .

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Gulfcut 21C is a sulfurized mineral oil. Its transparent light color permits close observation of the workpiece. It stands up well under tough machining conditions because it provides greater sulfur activity over the entire range of the cutting operation.

See for yourself how Gulf makes things run better! Call your Gulf Sales Engineer at your nearest Gulf office. It's his business to help. Meanwhile, write for your free copy of "Metal Machining with Cutting Fluids," the new 116-page handbook on their selection and use.

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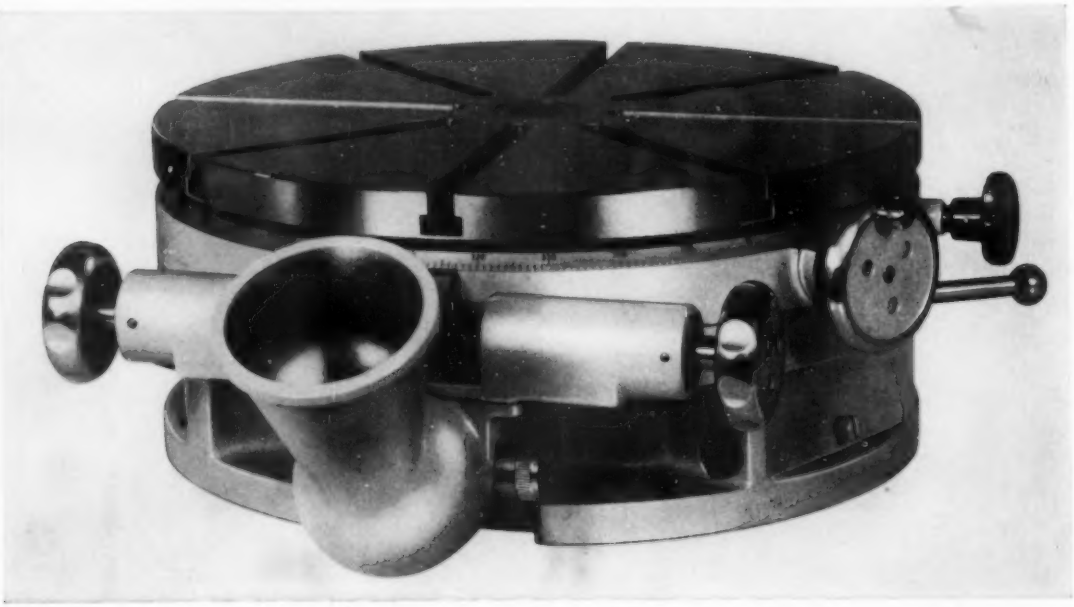
SP-9865

NEW Optical Rotary Table



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Unlike conventional instruments, the new Carl Zeiss Optical Rotary Table is equipped with a graduated disc, which is imaged on a big, bright ground-glass (80mm diameter). This makes reading most convenient, speedy and non-tiring.

Its large chucking surface of 400mm diameter, precision setting of 6 seconds, and its sturdy construction enable it to meet the most exacting requirements.

Quick, approximate setting is made by means of a handwheel and a circular graduation of 360°, located on the rim of the instrument. The precise setting of the angular values is achieved by a fine adjustment knob while observing the ground-glass.

All mechanical and optical parts are contained in the housing, safe from dust and moisture.

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True alignment of the machine spindle and axle of the rotary table is assured by a 20x microscope, placed in the machine spindle above a center point inserted in the rotary table. Both the center point and the centering microscope are equipped with a Morse taper 3. Therefore, if desired, the centering microscope can also be inserted in the rotary table and the center point in the spindle.

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Write for booklet on the Carl Zeiss Optical Rotary Table

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TOOL ENGINEERING in Europe

By H. Kronenberg
Consulting Engineer
Cincinnati 6, Ohio

Grinding Vibrations

A study of the nature and magnitude of vibrations occurring in plunge grinding operations was carried out in East Germany by V. V. Puzanov and is reported by him in an article published in the Russian magazine *Stanki i Instrument* Vol. 30, No. 2, 1960, and translated into English in *Machines and Tooling*. The title "The Nature of Vibrations Occurring During Plugne Grinding."

The workpieces were carbon steel with 0.6 percent carbon and were ground with three different grinding wheels. The vibrations of the workpiece relative to the table in horizontal and vertical direction were measured with induction pickups. Any change in the clearance between the workpiece and the pickup—which was attached to the table—caused a change in current in the coil of the pickup, which was amplified and recorded by oscillograph or oscilloscope. In order to remove interference currents due to residual magnetism in the rotating workpiece, a ring of sintered iron powder was mounted on the workpiece. A similar setup was used for measuring the oscillations of the end of the grinding wheel spindle relative to the grinding head.

The cutting conditions were varied over a wide range of speeds, feeds and so on and the results led to the conclusion that four different types of vibrations existed: vibrations with a frequency of 2.3 cps, corresponding to one revolution of the workpiece; vibrations with a frequency corresponding to the wheel rotation (32.5 cps); self-induced vibration—both torsional and flexural—of 950 and 225 cps respectively; and vibrations caused by an outside force (450 cps).

Many details are discussed in the article. The conclusion is that vibrations of the rotating workpiece cause an error due to eccentricity with respect to the centers. Vibrations caused by an out-of-balance of the grinding wheel do not affect the surface finish provided that the machine is arranged so that its frequency is equal to the frequency of the exciting force.

The self-induced vibrations predominate when the grinding wheel speed is 165 fps, causing frequencies from 900 to 1200 cps. For a wheel speed of 115 fps, the frequency range was 250 to 300 cps. Self-induced vibrations are greatly reduced when grinding with a wheel speed of 72 fps.

The amplitudes of self-induced vibrations increase with an increase in work speed and it was found that the best ratio between wheel speed and work speed for low vibration was 110 to 165. The intensity of self-induced vibrations increases with the dulling of the wheel. The external source of vibration was traced to the oil pump.

The machine was mounted on a conventional shop foundation, causing a natural frequency of vibration of the machine in the horizontal direction of 37 cps, which was close to resonance when the grinding wheel was running at 1950 to 2500 rpm, with an exciting force between 32.5 and 41.6 cps.

Thermal Distortions

When the shop temperature changes as little as ± 1 deg per hour, the bed of a machine tool will be distorted 0.00016 inch per 100 inches length, according to an article by N. Sokolov appearing in *Stanki i Instrument* and translated into English in Vol. 30, No. 2, 1960, of *Machines and Tooling*. The title: "The Effect of Shop Temperature on the Accuracy of Dimensions and Shape of Components."

After deriving the basic principles and an equation of thermal inertia, the author develops formulas for thermal deformations of machine parts in which the mass is uniformly distributed with respect to a symmetry axis. He also considers thermal distortions due to sudden temperature changes and those due to a gradual change in temperature. Likewise considered are cases where the mass is unevenly distributed with respect to an axis.

Several examples of the application of these formulas are given in the article. A sample problem: What time is required before measuring a precision leadscrew heated by 5 deg during a grinding operation, if the desired accuracy is 0.0002 inch over a screw length of 15.75-inch and 1.57-inch diameter? The answer is 2.3 hr.

Other examples deal with determining the change in the pitch diameter of a gear caused by temperature change, when the shop temperature varies according to a sine law and the thermal distortions depend not only on the magnitude of the change in temperature but also on whether the changes are spread over a long time or are occurring rapidly.

Piezoelectric Surface Testing

Average roughness of surfaces can be determined directly by means of piezoelectric devices. The devices are used in measuring instruments developed in Denmark and discussed in *Werkstatt und Betrieb* by E. T. H. Jens T. Broch. His article is entitled: "Oberflaechen-Pruefung mit piezoelektrischen Aufnehmern." The article appears in Vol. 93, 1960, No. 5, p. 259-261.

Several interchangeable tracer fingers are used to cover the various ranges of roughness and waviness. A "normal finger" has a tracer point radius of 12 micromillimeters. The radius at the point of a "fine finger" is only 2.5 micromillimeters. Another stylus for even higher accuracy is being developed. All these stylii have diamond points and act on a built-in piezoelectric element. The element, which is transversely deformed by the surface valleys and peaks, generates an electric current.

The instrument is equipped with a three-step switch, permitting a change from roughness to waviness measurements. Speed of tracing should not exceed a certain minimum in order to avoid any failure of the piezoelectric transformer to register the dynamic bending moment. On the other hand, the speed should not be higher than 10 mm per second—a value determined by the natural frequency of the system (about 1300 cycles per second).

Static pressure at the tracer point is about 0.5 g in the case of the "fine" tracer finger. When using this finger the rate of motion should be about one-sixth the speed of the normal tracer so that the stylus can accurately follow the surface under test.

Machining Helix Tools

In the milling, grinding and sharpening of helically grooved tools, the relationship between diameter, lead angle, pitch and the angle of inclination—and the data for setting up the machine—should be made known to the shop in order to avoid delays and machining errors. Th. Fiala discusses the mathematical relationships involved and gives suggestions for standardizing the helix angle of such tools in an article published in the May 1960 issue of *Werkstatt und Betrieb*, p. 235-238. The title of this article is: "Das Fraesen und Schleifen drallgenuteter

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Tool Engineering in Europe

Werkzeuge und ein Vorschlag fuer die Normung der Drallsteigung."

Since the equation for the lead angle contains the quantity π, which is an irrational value, the lead angle is also an irrational value, that is a quantity which cannot be expressed by a finite decimal number. In the case of the conventional method of milling helical grooves, on the other hand, the pitch is a rational number. Hence, if a definite lead angle is required it cannot be produced with mathematical exactness. Its real value will always deviate to some extent from the nominal value. This may not be serious in all cases, but could affect performance when extreme accuracy is required.

The author shows that it is theoretically impossible to obtain the same pitch when the milling operation is performed in a setup where the pitch has a rational value and the grinding operation is performed with a pitch of irrational value.

The article also covers the effect of sine bars and gear ratios, suggesting that helical grinding be combined with sine-bar settings, which can readily be obtained with high accuracy. In the author's opinion, the pitch should be standardized as a multiple of the quantity π and tables developed similar to those for gear pitch.

Ceramic Tools

Negative rake angles on ceramic tools are recommended only for machining steel and cast iron in the higher brackets of hardness while zero rake should be used when machining steel that is softer than 170 Bhn, according to an article in the Swiss magazine *Technica*, No. 1, 1960, p. 5-9. The title: "Zerspanung mittels oxydkeramischer Schneidstoffe."

A true rake of +10 deg is advisable when machining aluminum. Brass, carbon and hard paper should be machined with zero deg true rake. The clearance angles should be ground to 6-8 deg, which appears to be possible only when brazed-on tips are used.: For clamped-on tips, the clearance angle is usually equal to the true rake. These recommendations are apparently based on experience with German-made ceramics.

From a diagram published in the article it can be seen that the feed per revolution should be adapted to the point angle and the radius at the tip. As an example, for a 90-deg point angle, the feed should be dropped from 0.013 ipr in the case of a radius of 0.080 inch, to 0.010 ipr when the radius is only 0.020 inch.

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technical shorts

Oil Retained In Sintered Nylon Parts

New porous nylon parts which absorb as much as 50 percent of their weight in oil have been developed by The Polymer Corp., Reading, Pa. Oil-retaining ability of the parts is not impaired by extremes of pressure, temperature and acceleration. Approximately 20 percent of the oil is retained even after centrifuging at pressures in excess of 15,000g.

The nylon components are formed by cold pressing and sintering specially processed nylon powders by techniques similar to those used in powder metallurgy. Applications include bearings and wear parts where low frictional lubricated surfaces must be maintained over indefinite periods without subsequent lubrication.

* * *

Process Produces Forgeable Tungsten

By combining electron beam processing with critical composition control, metallurgists of Stauffer-Temescal have effectively reduced grain size in cast tungsten and molybdenum ingots. This technique has substantially increased the ductility and machinability of these metals without impairing their strength. It has also been successfully applied to a range of other alloys including those of columbium and tantalum tungsten.

* * *

Automation Studied with Computers

Effects of automation upon men who supply its necessary human element are now being evaluated at Battelle Memorial Institute. Implementing the study, an unusual problem-making computer simulates a variety of control-board problems.

People serving as subjects in the Battelle experiment are required to control a needle in a dial mounted on the control panel. No operator decisions are required when a fully automated condition is simulated, but when a light flashes, simulating trouble, the subject is required to control the needle by pressing the right buttons.

The control panel requires constant attention from the operator who, at any given period, is required to manually answer three consecutive questions: "Is the system functioning correctly?" "If not, what correction is required?" "Was the action taken effective in correcting the trouble?"

Because these questions are ever-present in even the most sophisticated systems, proper evaluation of the human variable is mandatory. As automation systems become more complex, human reaction time will become more critical in its influence upon design.

Stainless Steel Provides Hot Hardness

A special grade of stainless steel developed by Latrobe Steel Co. promises to have wide-spread usage in high-pressure applications. Developed primarily for use in the landing gear of jet aircraft, the metal can be subjected to pressures of more than 600,000 psi at temperatures in excess of 800 F. Without loss of hardness.

Chemical composition of the steel is 1.10 C, 0.3 Mn, 0.30 Si, 14.5 Cr and 4.00 Mo, making this material a modification of AISI Type 440-C stainless. The desired hot hardness is obtained by increasing molybdenum content from 0.005 to 4.00.

Designated as Lesco BG41 Vac Arc, the steel is produced by the vacuum consumable-electrode process.

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Tech Digests

Radioisotopes Monitor Machining

Operator control of highly automated machines is somewhat limited, and cases have occurred of runaway of the automatic equipment functioning under error. The result is a sort of automated "hara-kiri." Monitors are proposed to avoid the consequences of system failures. An adaptation of a back scatter technique has promise. Compton scattering of gamma rays involves the interaction of an incident gamma ray with an orbital electron of an atom in the scattering media. In the instrument utilizing this principle, incident gamma rays pass through a restricted opening to impinge on the material being measured. Radiation interacts with the target material and a small but significant portion is scattered back toward the detector. The quantity so scattered is the direct measure of the thickness for a constant density. The reflected radiation is detected by a scintilation crystal that converts high-energy radiation to light. Light energy is in turn converted to an electrical signal, and amplified for display on a recording meter. The device has been used successfully to inspect simulated defects in heat exchanger tubing.

Suggested and potential applications are a probe for measuring a change in shape or contour. Also, the device can be used to monitor the position of a cutting tool relative to a workpiece and respond to any unwanted variation in relative position. Another potential application is for monitoring thread contour relative size, shape and position. The probe device has been used for rapidly inspecting the internal helical keyways of a machined piece. The piece is inspected for width, depth and position of cut. The device also has been used to measure concentricity of holes bored in engine blocks.

Based on SAE Paper No. 181C by J. H. Tolan, Lockheed Aircraft Corp. Presented at the Summer Meeting of the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

▼ ▼ ▼

Reliability Prediction

A basic form of reliability prediction is stress analysis, which has been used a long time. What is new about reliability prediction today is the increased emphasis on time as the critical dependent variable. As hardware becomes more evolved, it tends to become more complex and contain more components. The item is regarded as a "system" and for its successful operation is analyzed for reliability from the point of view of the individual components and the overall system. Without this kind of analysis, technological innovations operating today would have been unfeasible. As a discipline or concept, reliability prediction is applicable to any complex system, composed of many components, or operations. It applies to manufacturing as well as part design.

This introductory survey of reliability prediction is intended for the engineer not acquainted with the subject and draws for examples on the complex systems of space technology and weapon systems. To help an engineer use reliability concept as any engineering tool, the paper is developed in three main parts. The first part is an introduction to reliability prediction, the second part examines the validity of such predictions and the third part outlines some of the uses of reliability predictions in operations analysis, maintenance, design and value engineering.

In the introduction to reliability prediction, the six categories of failure are indicated, and random-failure is discussed. Life models, system survival probabilities, system and part failure rates are discussed.

The validity of reliability prediction is examined briefly in nonmathematical terms. By the use of accumulated system histories, a sample was made to authenticate validity of predictions made concerning the systems. It is concluded that reliability prediction is valid and dependable, though not precise and highly accurate.

Some of the uses of reliability prediction are indicated. These are primarily in terms of space and weapons systems but analogous to industrial operations and include determining maintenance force requirements, availability and stand-by requirements, operational force requirements, methods for optimizing reliability at minimum cost and so forth.

Based on ASME Paper #60-MD-1 by Thomas C. Reeves, Radio Corp. of America, presented at the Design Engineering Conference and Show. The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

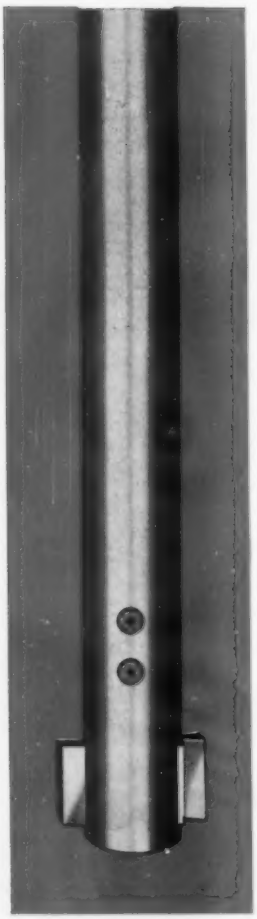
▼ ▼ ▼

Nitriding for Wear and Fatigue Resistance

Gaseous nitriding has not expanded into wide use as it is costly, has long time cycles, requires considerable capital equipment outlay and sometimes produces an undesirable brittle white layer on some materials. A liquid nitriding process, under the commercial name Tufftride, obtains good results industrially and is applied to low carbon, alloy, stainless, tool steels, heat resistant steels and also to gray, alloy, modular or ductile, malleable and pearlitic irons.

In the process, low-carbon steel is immersed in a specially formulated molten salt bath operating at 1050 F. Decomposition of the salt in contact with the steel liberates specific amounts of carbon and nitrogen. Because of their difference in solubility rates, carbide quickly forms iron carbide particles at the surface of the part. The iron carbides act as nuclei so that nitrogen precipitates at the surface to form desirable iron nitrides. This outer surface is known as the compound layer.

Various tests run on nitrided pieces demonstrate its properties. Wear resistance is improved, an increase in endurance or fatigue life results and hardness improves. Various tests and demonstrations are shown for different metals, comparing the nitrided with a non-nitrided surface, for workpieces such as crankshafts, camshafts, gears,



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- Cutter adjustable in bar — cutter need not be removed from bar to make size adjustments. Diameter can be changed in seconds by simply turning adjusting screw.
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- Speed and Ease in Regrinding — You grind only two edges, then set accurately to size desired.
- Tolerances can be held to .0005" and the finish produced is from 50 to 100 R.M.S. depending on feed, speed and material.
- No floating holders are required — cutter has floating action in bar.

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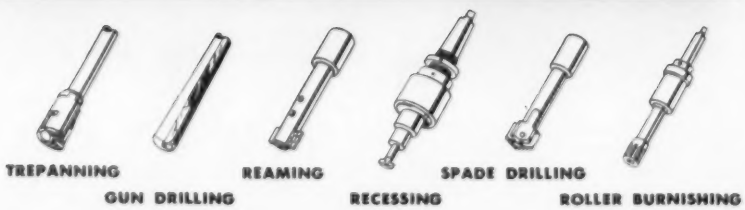

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splines and so forth. Used on tools, more workpieces result. A forming tool of M-3 high-speed steel was treated at 1000 F for fifteen minutes and air cooled. It produced 38 percent more pieces than the nontreated tool. Similarly, high-speed trim dies showed an increase or 25 percent in the number of prices processed. Data are given for similar examples involving forming punches, forging dies, cutting tools and thread cutting dies.

Based on SAE Paper No. 178B by John H. Shoemaker, Kolene Corp., and George Bidigare, Commercial Steel Treating Corp. Presented at the Summer Meeting of the Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

TO REQUEST COMPLETE PAPERS WRITE TO THE ADDRESS AND ORGANIZATION INDICATED AT THE END OF EACH ABSTRACT

New Welding Processes

As new materials are developed and employed, the problems of fabricating by welding must be resolved. New developments and methods occur in welding and it is important for those concerned with fabrication to avail themselves of this knowledge. Many of the processes developed introduce cost savings. For these reasons, a review of the newer welding processes, refinements and improvements of basic older processes is in order.

Pressure welding applies to the group of welding processes in which force is used to obtain coalescence of metal. Ultrasonic welding, whether spot or seam, has been mostly successful for welding foil, though welds of 0.09-inch sheet have been made that exceed military specification requirements. High-frequency resistance welding has the advantage of high speed. Speeds up to 1000 fpm can be obtained in light gage material. Also, a narrow heat-affected zone is obtained. Foil seam welding is important where high speed and freedom from distortion are required. Magnetic force welding, where electrode force is synchronized with current magnitude and duration, has solved difficult welding problems. Percussion welding produces the weld either by a rapid discharge of electrical energy from a stored-energy source or by rapid dissipation of current. Friction welding is considered a new process. Heat produced by friction fuses the parts in place. As the workpieces are usually rotated to develop friction, the process is presently limited to cylin-

drical shaped parts. Thermopressure welding uses pressures ranging from 5000 to 10,000 psi and temperature ranges from 200 to 300 C. The process has been used primarily for joining semiconductors without using chemical fluxes. Diffusion-bond welding occurs when the metals are heated to temperatures below their solidus and held under pressure. No liquid phase is formed and bonding occurs by movement of atoms or intermetallic compounds across the intimate contact. The process has promise for joining many dissimilar types of metals and alloys.

Fusion welding processes use heat primarily to obtain coalescence of metal. Electroslag welding is used primarily for welding heavy sections. Fusion of the electrode wire and parent metal takes place under a molten-slag bath covering the metal bath which forms the weld. A high metal deposition rate is obtained. Electron-beam welding is based on the impingement of electrons on a workpiece in a high vacuum. High-purity welds are the advantage of this process over others. Also, the process obtains a deep penetration. Arc-plasma has been used primarily as a source of heat and also for ceramic material deposition. An inert gas is passed through an arc. The flow of electrons from cathode to anode ionizes the gas and causes it to be heated to extremely high temperatures. The plasma emitted consists of a hot stream of high-speed ions and electrons flowing at subsonic to ultrasonic speed ranges.

Brazing is applied to processes in which coalescence is produced by heating to suitable temperatures above 800 F and by the use of filler metal having a melting point below that of the base metals. Flux may or may not be necessary. The process has been of great utility in sandwich construction of aircraft components.

Further developments on new welding processes, new welding power sources, and new concepts of welding are expected.

Based on ASME Paper No. 60-MD-3 by John J. Chyle, A. O. Smith Corp., Milwaukee, Wis. Presented at the Design Engineering Conference and Show of the American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Use of High-Speed Steels

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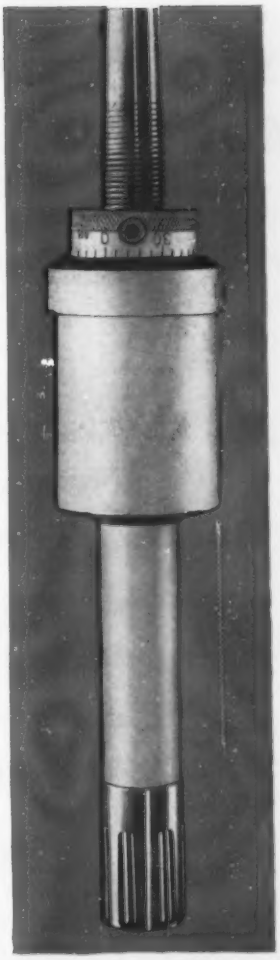

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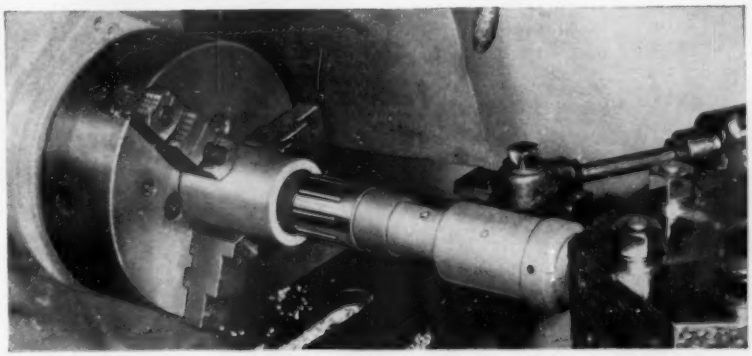

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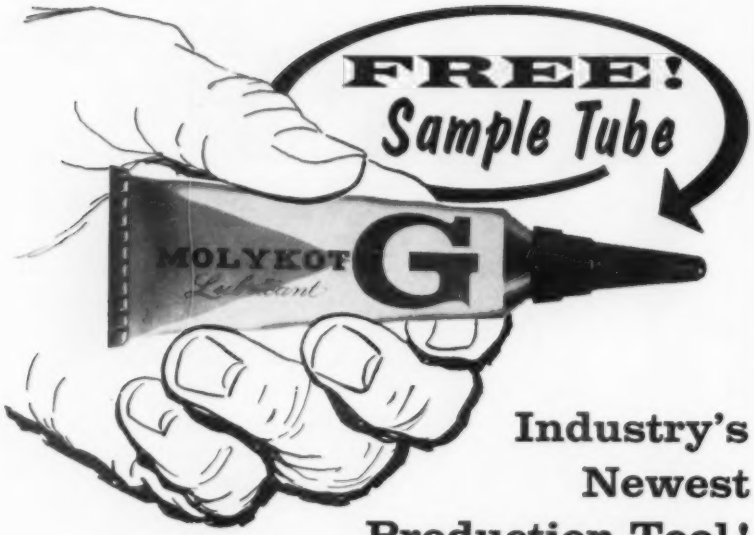

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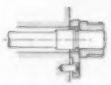

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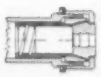

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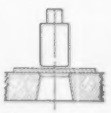

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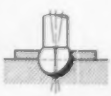

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penalties are incurred. The alloys lose ductility and toughness and extra care must be taken in almost all operations; special procedures must sometimes be devised for fabricating and processing the material.

Low alloy hardenable steels, chromium hot-work die steels, martensitic stainless steels, semiaustenitic precipitation-hardenable stainless steels and cold-rolled austenitic stainless steels are discussed. The uses and properties of each steel as well as practices and problems with the steel are indicated. From accummulated experience with these families of steels, improved methods in handling them have been developed. From an understanding of the material's properties and the experience, manufacturing methods for coping with the steels successfully are indicated.

Based on ASME Paper #60-MD-9 by A. M. Hall, Battelle Memorial Institute, presented at the Design Engineering Conference and Show, The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

▼ ▼ ▼

Analysis by Analog Computers

Analog computers, as engineering tools, save time and effort in solutions to feedback control systems. The mathematical model of the system is constructed with electrical devices and its performance simulated.

Physical systems, such as mechanical spring-mass damped systems have relationships analogous to those ocurring between electrical elements. Setup of a mechanical system can be complex, costly, and perhaps unreliable. Setup of an electric analog is in effect a simulation of the mechanical hardware.

A given mechanical system can be simulated by making a block diagram of the equation applying to the mechanical system and then, by analysis, selecting and combining the electronic means of analog computation for the mechanical system.

A mechanical system simulator is explained and developed. The block diagram, electronic blocks and analog computer setup for mechanical systems are fully developed. The transfer function method of simulation for complex transfer impedance is also explained. Appended tables show 24 transfer-impedance functions, networks, relations and inverse relations.

Based on ASME Paper No. 60-MD-7 by William E. Sollecito, General Electric Co. Presented at the Design Engineering Conference and Show of The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N. Y.

Gear Failures

Within the last fifty years carburizing has become more of a science and less of an art, and it is commonly used for heavily loaded gears. Standards came into being that specified case thickness on the basis of tooth thickness. These standards appear to be inadequate for many nonstandard gear designs. There are strong reasons for believing that case thickness should be chosen on the basis of considerations other than tooth thickness. To show the need of a redefinition, two types of failures are discussed: (1) pitting fatigue and (2) case crushing.

Pitting generally originates in the dedendum region of driving pinions and from the point of origin, a crack spreads in a characteristic V-shape toward the tip of the pinion tooth. The crack extends a short distance into the hard case, travels parallel to the surface, and then returns to the surface. In case crushing, the cracks are not limited to the addendum or dedendum region, but extend over most of the tooth profile. The crack extends below the hard case and most of its length is in the softer core material. The gear tooth has the appearance of being gouged longitudinally. Case crushing and pitting are two distinct types of failure.

Test results indicate correlations between the incidence of case crushing and the thickness of the carburized case. It is believed that case crushing failures are not due to maximum shear but are related to the ratio of shear stress to shear strength of the material at the subsurface level where the hardened case meets the softer core. Based on analysis of shear stress and strength, the authors feel that maximum stress/strength ratio should be no more than 0.55 in order to minimize case crushing. If the method of analysis reveals that case crushing failure will result, either case depth should be increased, core hardness increased, or a combination of both. This would be a more rational approach to the selection of case thicknesses of carbides and hardened gears than is available in the present standards.

Based on SAE paper No. 220 by R. Pedersen and S. L. Rice, Caterpillar Tractor Co. Presented at the SAE National Farm, Construction and Industrial Machinery Meeting. Society of Automotive Engineers, Inc., 485 Lexington Ave., New York 17, N. Y.

Molybdenum Grease

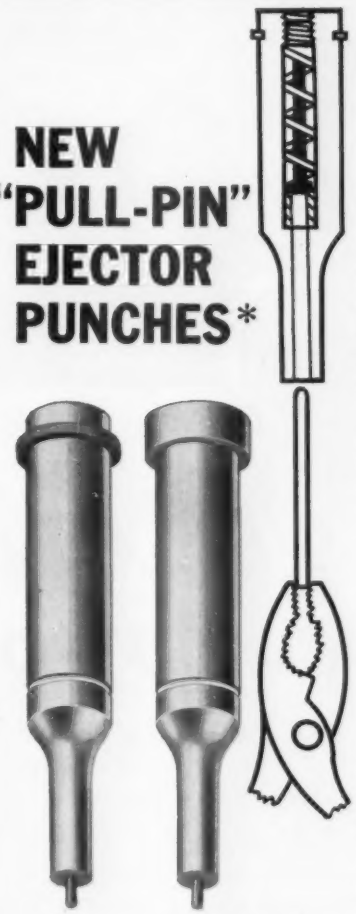
Molybdenum disulfide has a molecular structure of the type called layer-lattice and consists of a layer of molybdenum atoms sandwiched between two layers of sulfur atoms. The bonds holding the sulfur atoms to the molybdenum are strong, but the bonds between sulfur atoms in adjacent layers are weak. The layers therefore slip or slide. These many slippage planes reduce friction.

Extensive field tests were conducted to evaluate the additive under service conditions. Moly in general reduced wear of lubricated parts by approximately one-half, reduced friction and made sliding joints move more easily. In severe service moly grease was successful in preventing bearing failures where they occurred when standard grease was used. The moly minimized friction corrosion of closely fitted assemblies. Spherical roller bearings running at 2050 rpm, 2000-lb load ran 20 deg F lower than the same bearing oil-lubricated, and 70 deg F lower than with grease.

In general, where the load on moving and metal parts is so great that the performance is marginal with conventional greases, the moly can be used advantageously.

Based on SAE paper No. 217 C, by C. D. Thayer and H. G. Rudolph, Jr., Socony Mobil Oil Co., Inc. Presented at the SAE National Farm, Construction and Industrial Machinery Meeting. Society of Automotive Engineers, Inc. 485 Lexington Ave., New York 17, N. Y.

NEW "PULL-PIN" EJECTOR PUNCHES*



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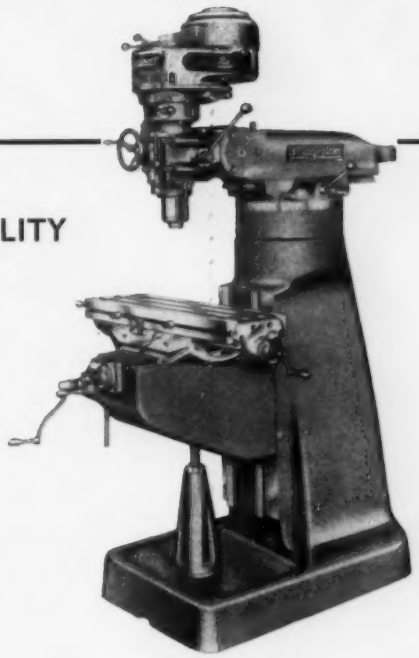

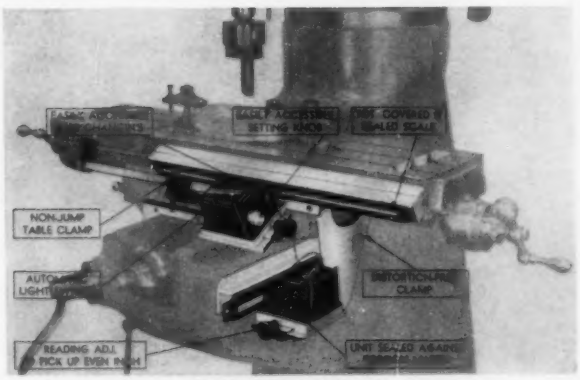

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. . . the Bridgeport Optical System can also be applied to the Bridgeport Milling Machine making it possible to locate holes and bore them to extremely close tolerances. Figures can be read on the scale just as they appear on the working drawing. This attachment is not dependent for accurate results on an operators skill. Quick positioning of table in both planes can be accomplished accurately and quickly.

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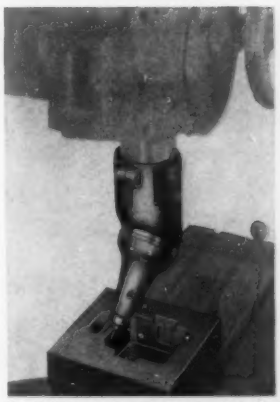
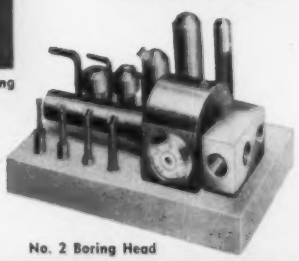


Quill Master set up for deep cherrying

Right Angle Attachment



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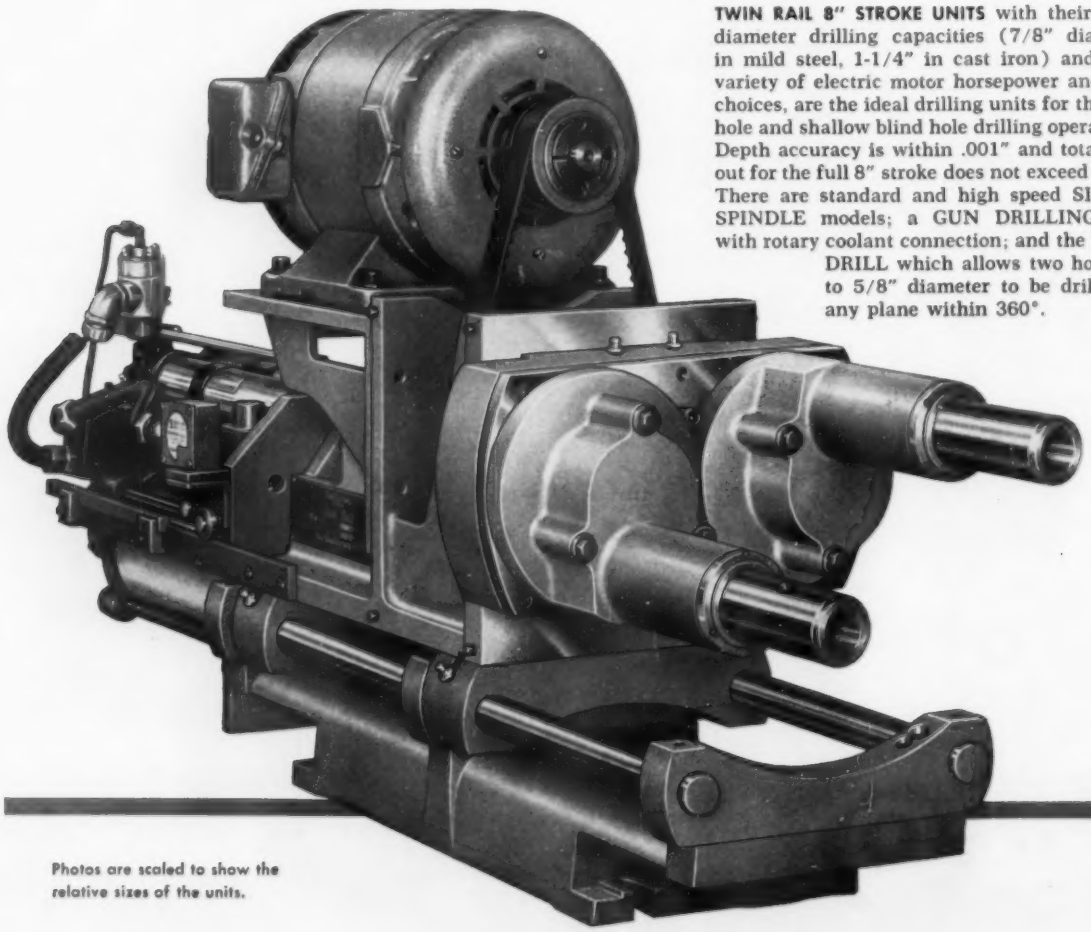

TWIN RAIL 8" STROKE UNITS with their large diameter drilling capacities (7/8" diameter in mild steel, 1-1/4" in cast iron) and wide variety of electric motor horsepower and rpm choices, are the ideal drilling units for through hole and shallow blind hole drilling operations. Depth accuracy is within .001" and total run-out for the full 8" stroke does not exceed .002". There are standard and high speed SINGLE SPINDLE models; a GUN DRILLING unit with rotary coolant connection; and the TWIN DRILL which allows two holes up to 5/8" diameter to be drilled in any plane within 360°.

Photos are scaled to show the relative sizes of the units.

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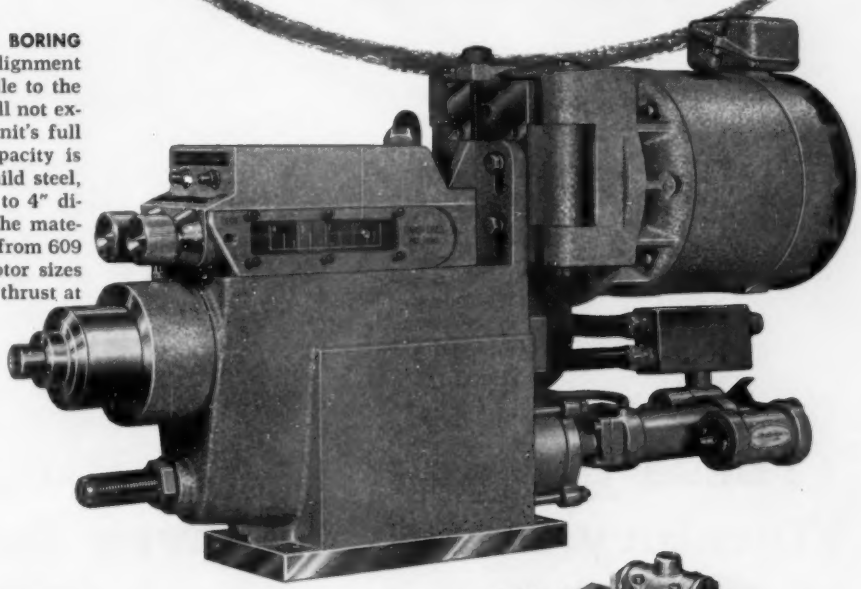
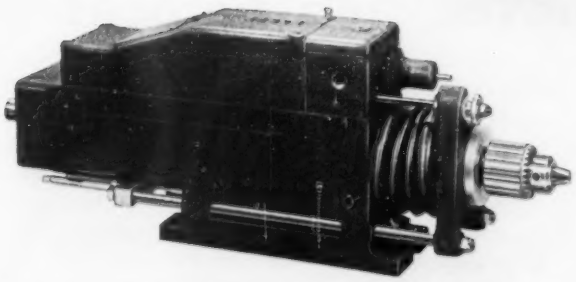
"CARBI-DRILL" PRECISION BORING UNIT has so perfect an alignment that total runout of spindle to the machined base surface will not exceed .001" T.I.R. in the unit's full 4" stroke. Its drilling capacity is up to 5/8" diameter in mild steel, boring capacity is 1-1/2" to 4" diameter, dependent upon the material. Spindle speeds range from 609 to 6275 rpm (electric motor sizes from 3/4 to 2 hp). Power thrust at the quill is equal to 10 times applied air line pressure.





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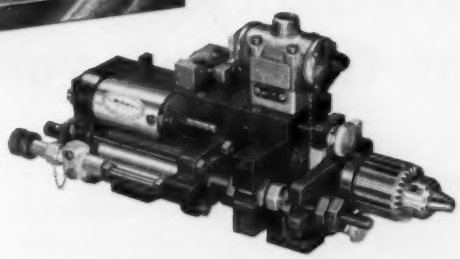

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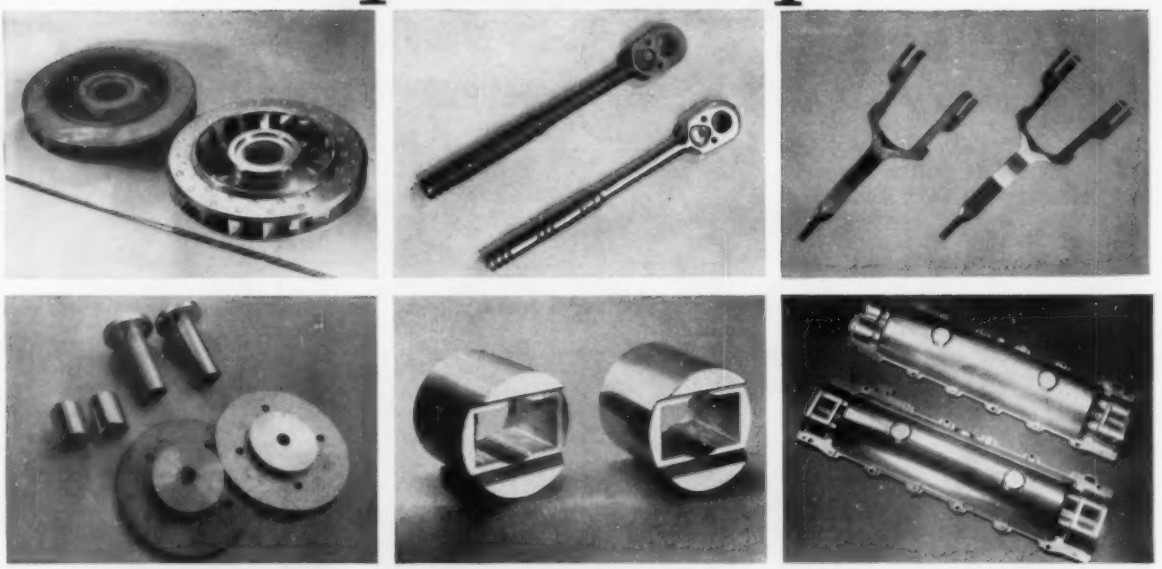

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* Pat. No. 2,422,786; June 24, 1947

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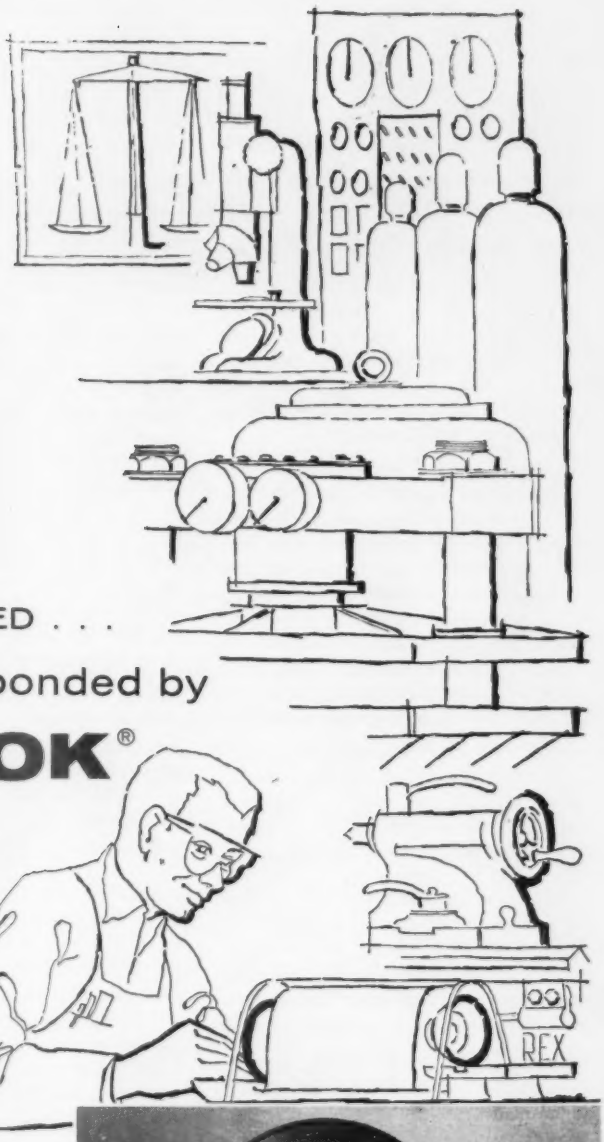

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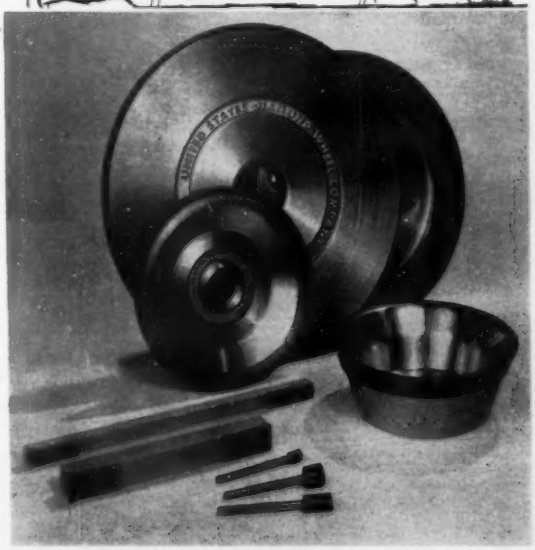
All of the new developments in Diamond bonding and processing are available *now* for use in your plant. The United States Diamond Wheel Co. makes the world's best wheels with man made or natural Diamonds.

"Progressive Specification" insures the best use of all the newest techniques and materials by on-the-job engineering.

Since the efficiency of either MD or SND is determined by the ability of the bond to present friable surfaces of the Diamond to the work surface, it should be readily apparent that PRESSURELOK Bond, which has 300% more Diamond holding power than other resinoid bonds, reduces carbide cutting costs over any other make of Diamond wheel.



For a free reprint of the outstanding article on "Diamond Wheel Test Program Pays Off" at Ford Motor Company (in this issue) and information about how you can have these same advantages in your plant, contact the United States Diamond Wheel Co., 835 Illinois Ave., Aurora, Ill.

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NEW IDEAS IN COPPER ALLOY ROD AND WIRE

Interesting things happen when you add a spot of zirconium or chromium to copper—four high-conductivity coppers that boost production, cut cost of machining—even plain old free-cutting brass rod is going fancy.

There's a quiet revolution going on in copper metallurgy. Research and development teams are expanding the useful knowledge of copper and copper alloys in an effort to define the properties most suitable for specific engineering applications.

STABILITY at elevated temperature, combined with good electrical conductivity, is probably a combination most sought after by design engineers and by our industry's research teams. Two alloys are now commercially available, and the alloy systems are unique. Chromium copper and zirconium copper are heat-treatable alloys with good stability of mechanical properties up to temperatures in the order of 600 F.

CHROMIUM copper in the fully heat-treated condition following a solution anneal will exhibit properties combining a tensile strength of about 75,000 psi with conductivity of approximately 80% IACS. Zirconium copper has good stability characteristics at elevated temperatures and conductivity of 90 to 95% IACS; the strength properties developed by heat treating are, however, somewhat lower than chromium copper.

SEVERAL other heat-treatable copper alloys with intermediate properties are gaining recognition in the connector and electronics fields. These alloys fall into a conductivity range of 35 to 65% IACS, with tensile strengths 90,000 to 100,000 psi. The most popular alloy systems are the copper-nickel-phosphorus and copper-nickel-silicon series with modifications for free machining or other specific requirements. These alloys have a solution annealing temperature about 100 to 200 C lower than the chromium and zirconium coppers.

THE WIDESPREAD use of panel or harness construction for linking segments of electrical control devices has made the requirement for free-cutting coppers mandatory. Screw machine shops are fabricating these connector components of various designs by the millions. Currently the most popular free-cutting coppers are leaded copper with conductivity of about 98% IACS, and tellurium and sulfur coppers at about 95% IACS. Some of these free-cutting coppers have residual oxygen and can become brittle or gassed under the usual conditions contributing to this phenomenon. All, however, can be obtained with a combination of deoxidizers or oxygen-free copper. In the case of the deoxidized variety, some slight sacrifice in conductivity will be noticed. Ordinary usage very seldom requires conductivity in excess of 90% IACS – and this presents no problem for these coppers.

ALL of these coppers can be cold worked without too much trouble. They can be supplied in a suitable wire temper for cold heading and secondary operations designed around the basic alloy system. Up to now there has not been too much interest in these alloys for wire forming or heading operations. Close dimensional tolerances may be the reason for the reluctance of the heading people to get into the electrical connector business. Alloys are available with the ductility and mechanical properties necessary for this type of forming. It would appear that some of the products could be made more economically by cold-heading or wire-forming operations.

RECENT TRENDS have also affected the old brass and copper reliables. There can't be any product more prosaic than free-cutting brass rod; it is the cheapest of such commodities and at one time was the easiest to process—all one had to do was to extrude, draw to finish dimensions, and ship. In many cases this practice won't work today. Deep drilling, roll threading, knurling, staking, slotting, etc., have complicated the picture, but the latest efforts of the screw machine builders have laid this ghost to rest. We now hear of beta-free rod for close tolerances on deep-drilling applications. Similar grain structures, but not necessarily the same temper, are required for roll threading, knurling and staking or whenever extra ductility is needed. Along with the consideration of grain structure, it has been necessary to take advantage of the broad chemical composition range for free-cutting brass. Most suppliers divide the standard range into two parts, utilizing the lower copper range for the larger sizes that will normally be machined on the heavier, faster screw machines where chip breaking and clearing the tools are the most important considerations. This might be considered the rough, breakdown type of stock.

FOR the smaller diameters, specialization has been the watchword. Depending on specific needs, you can now obtain free-cutting brass rod with all-alpha, fine-grained structure or an alpha-beta fine-grained extruded structure, or possibly a combination of both. For certain applications you might need a coarse-grained, all-alpha structure. Lead dispersion and lead content are other variables that can and will be controlled to meet fabricating or end-use requirements.

IN the cold-heading industry, advantage is being taken of the wider selection of copper and copper alloys that is available today. The nickel silvers, phosphor bronzes, and silicon bronzes combine good ductility and high strength with excellent corrosion resistance. The whole range of common brasses has specific applications and can be tailored to various heading operations.

The research and development hopper is full of interesting new ideas and projects at Anaconda American Brass Co. It could be that we're working on something which would help solve one of your problems. Even though we don't have the complete answer, perhaps we could both reach a solution faster by pooling our efforts. Call your Anaconda representative and talk it over with him or write: Manager, Market Planning, Anaconda American Brass Company, Waterbury 20, Conn.

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Still in the early experimental stage, this phototransistor is a tangible result of the General Motors Research Laboratories' program on semiconductors – particularly the group II-VI compound, cadmium sulfide. Behind its development lies the steady accumulation of (1) know-how in crystal growing, doping, and contact preparation and (2) information about CdS's intriguing solid state properties (red or green luminescence, high photoconductivity, short relaxation times, etc.).

For the researcher, this three-terminal device is adding a new dimension to the fundamental understanding of semiconductors. For instance: GM Research scientists have uncovered the important role of photo-generated holes in modulating the conductance of this intrinsic semiconductor and have determined the hole drift mobility through a new theoretical analysis.

These semiconductor investigations illustrate the dual aim of GM Research: contributions to the science, advances in the technology of important new subject areas. Such research is the initial step in General Motors' continuing quest for "more and better things for more people."

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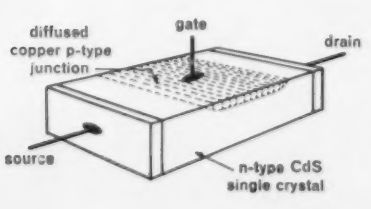

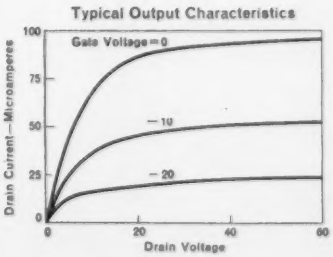

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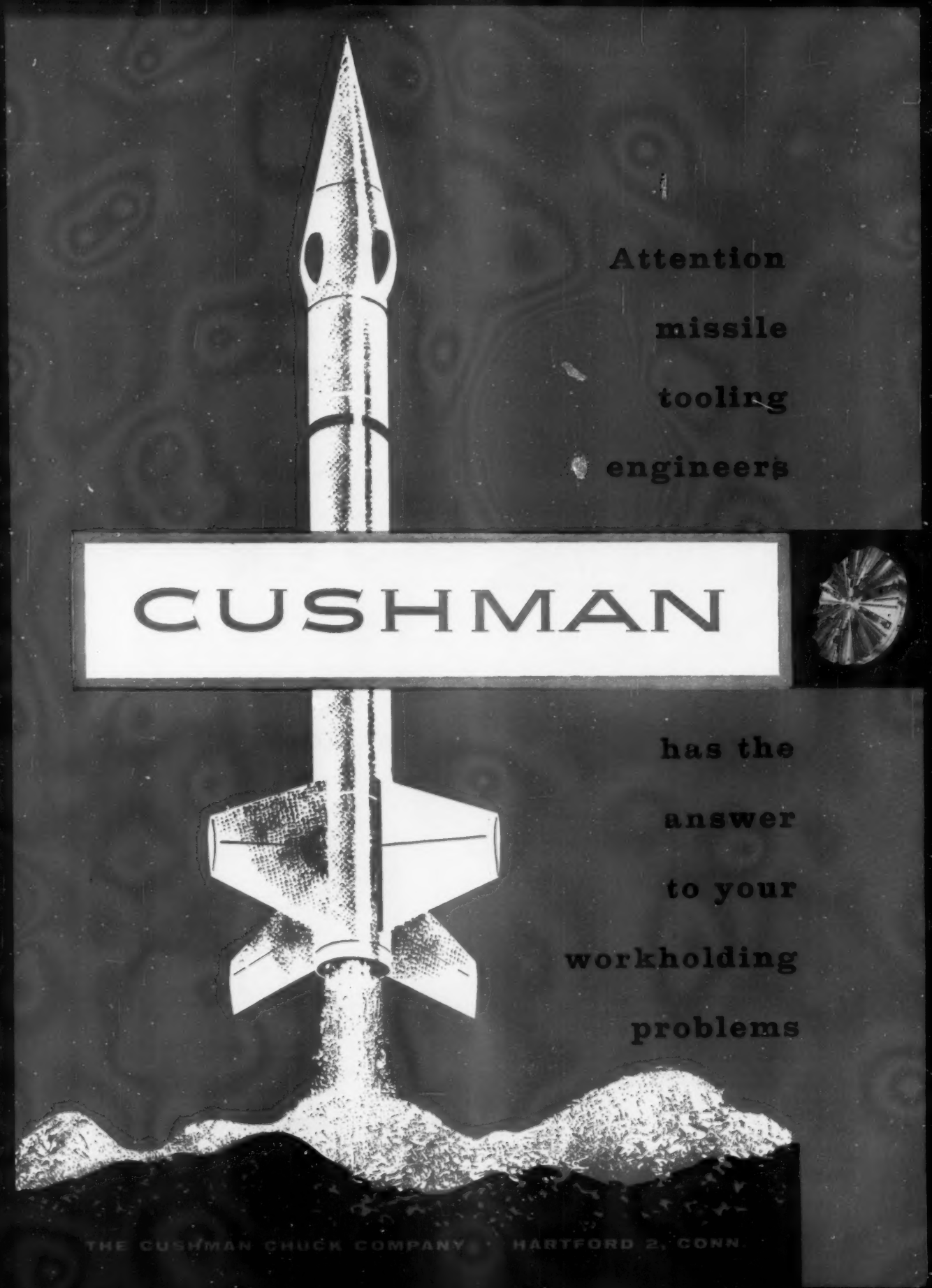
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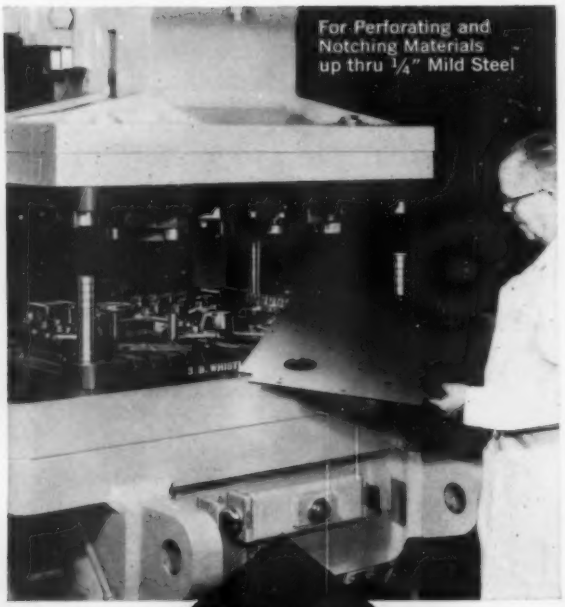

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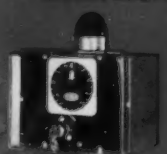

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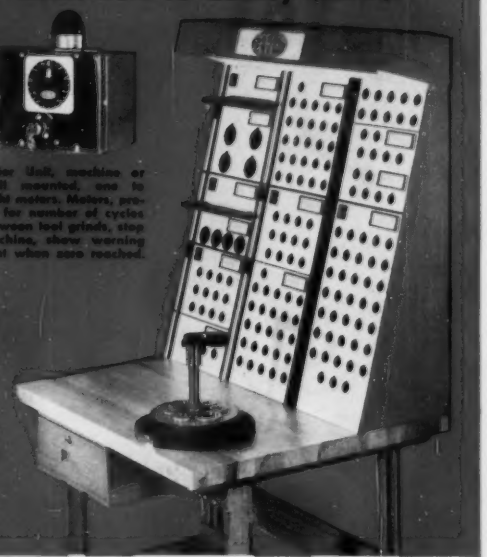

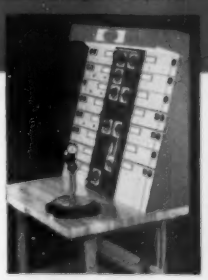

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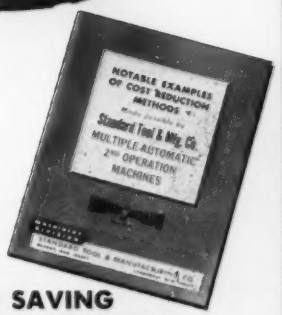

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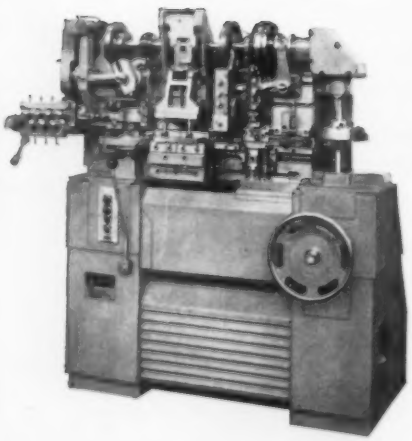

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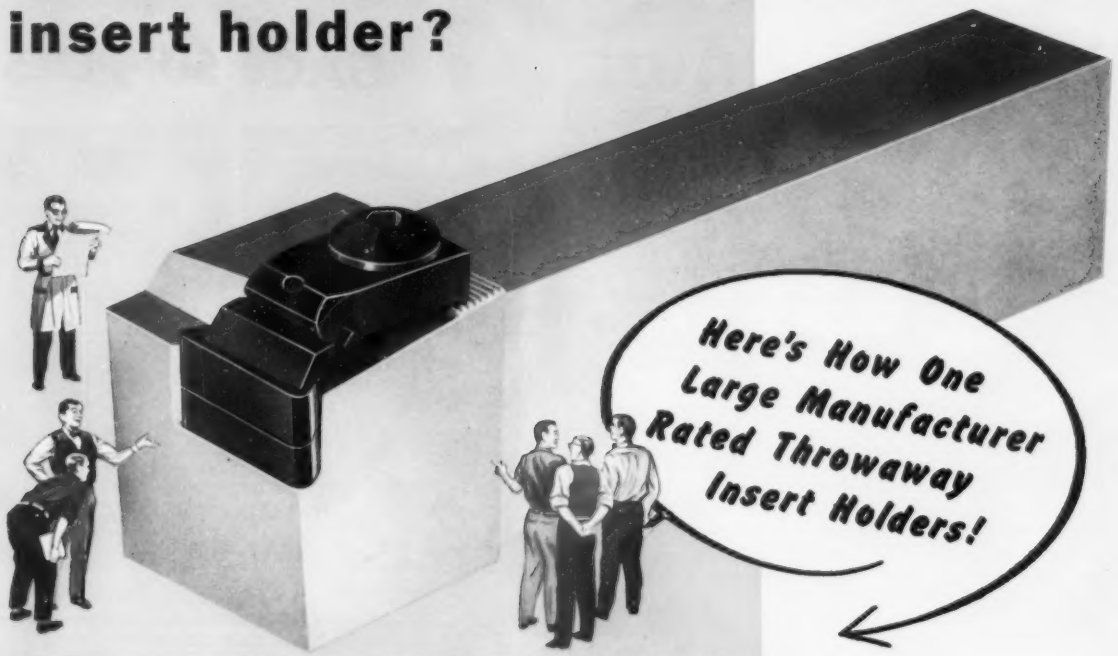

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							#1	#2	#3					#1	#2	#3			
Inserts of standard indexable design	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Adjustable chipbreaker	●	●								●	●	●	●	●	●		●		●
Surface to surface contact between chipbreaker and insert	●			●	●	●	●						●	●		●	●		
Replaceable chipbreaker—independent of clamp	●			●	●	●	●			●	●	●	●		●	●			
Removable locking pin prevents chipbreaker loss when indexing insert	●	●	●					●	●	●	●			●			●		
Clamp arrangement does not obstruct chip flow	●	●	●	●	●	●		●		●	●	●	●	●	●			●	
Clamp arrangement does not place an eccentric load on clamp screw	●	●		●	●	●		●	●					●	●	●	●	●	
Replaceable and indexable shim seat—stocked for variable insert thicknesses	●	●	●	●	●	●				●	●	●							
Holders available in all styles for positive and negative rake, and square and triangular inserts	●			●		●	●						●						

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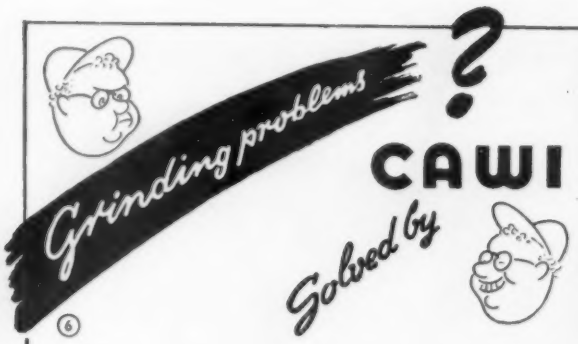

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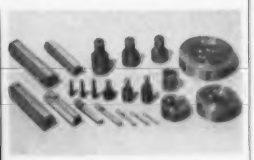
- ✓ INCREASE YOUR PRODUCTION TIME

Write for FREE Price List Catalog

TODAY!



immediate delivery

Huron's mass-production principle of quality, accuracy and dependability is your assurance of the "best for less". It is because of this quantity production that the prices are the lowest in the industry — yet quality unsurpassed. Let us prove to you that it's economical to buy from Huron.

Delivery from three stocked offices in central locations will enable you to better your present delivery schedule.

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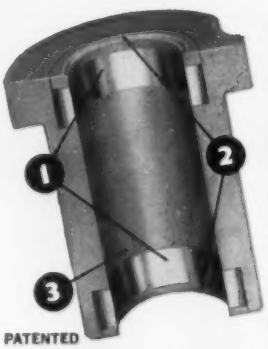
Does the job of Solid Carbide and MEYCO COSTS LESS!



PATENTED

1. Tungsten carbide rings at the points of wear; 2. Steel rings protect drills and carbide; 3. Special hardened alloy steel body.

There in a nut shell is the story of MEYCO carbide inserted drill jig bushings! Does everything a solid carbide bushing will do at less cost: lasts almost as long; increases life of drills and jigs; greater accuracy—longer; saves man-hours and machine down-time! All this spells high production at a lower cost. For over a decade, carbide inserted drill jig bushings have been saving money on long production runs for cost conscious customers.

Write for new Bushing Catalog No. 42

MEYCO **W. F. MEYERS CO., Inc.**
BEDFORD, INDIANA
A famous name in precision tools since 1888

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SIMONDS ALL-NEW SUPER HIGH SPEED STEEL METAL BAND SAW

This ALL-NEW SUPER HIGH SPEED STEEL Band Saw Blade

comes welded-to-length . . . ready to use . . . in striking, new package with cutting edges protected by a special plastic cover.

INDUSTRY REPORTS

Nothing Else Compares for Cutoff Production

The biggest advance ever in metal cutting band saw blades — that's Simonds *SUPER* High Speed Steel Metal Band Saw. No matter what ferrous metal you're band sawing, this brand new blade will give you *up to 3 times better performance* than any High Speed Steel blade you're now using!

This is not just a claim but a provable fact backed by Simonds' established reputation as a leading manufacturer of industrial cutting tools.

This *SUPER* High Speed Steel Band is an entirely new concept in band saws . . . new steel*, new manufacturing methods, new heat treatment, new welding techniques, new final inspection.

Laboratory and field tests demonstrate that this new saw is so much better in every way for production cut-off work that we are offering it on a PERFORMANCE GUARANTEED basis! You can't lose — you can cut your blade costs, save on down time, get the equivalent of up to 3 saws in better performance *at a cost of only 10% more than ordinary High Speed Steel blades.*

The sooner you try this new blade, the more you'll save! Get prompt delivery now of Simonds *SUPER* High Speed Steel Band through your Simonds Industrial Supply Distributor or your nearest Simonds Branch.

*Developed and made in Simonds own Steel Mill — Patent Applied For

Your nearby SIMONDS DISTRIBUTOR is your most dependable cutting tool supply source. His stocks and services are designed with your convenience and economy in mind. Call him FIRST for all your industrial supply needs!

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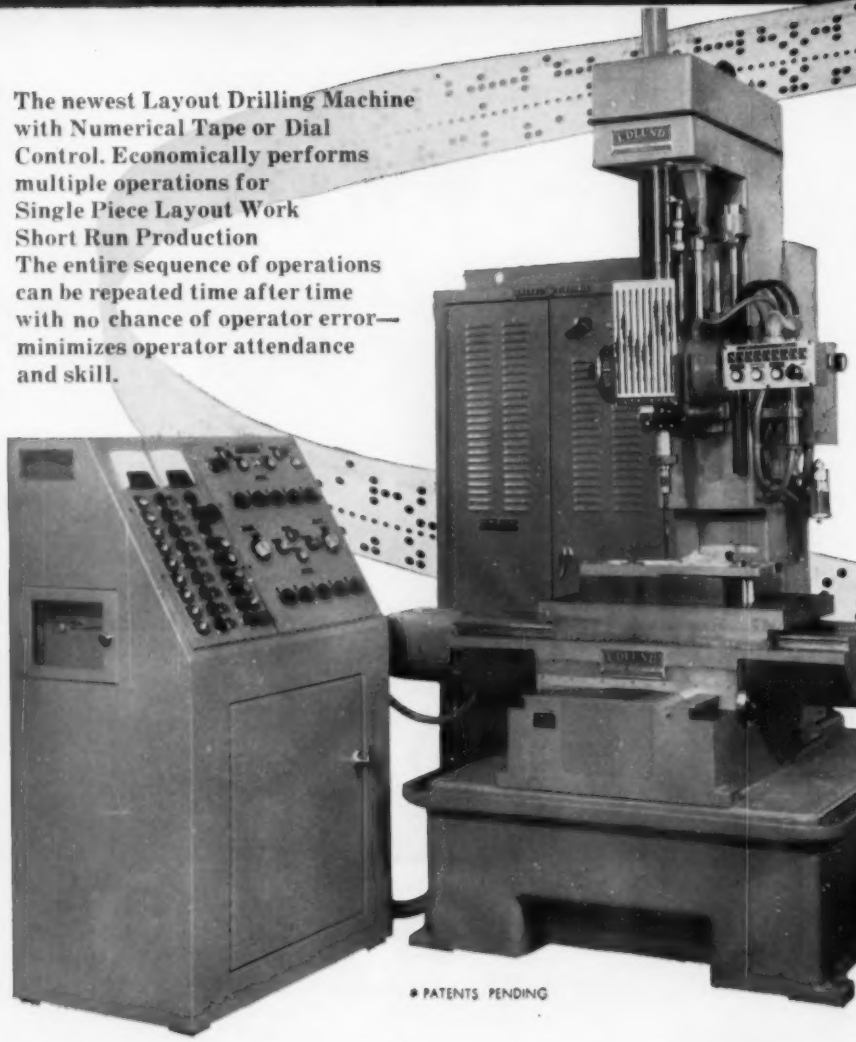
EDLUND-MATIC NUMERICAL TAPE CONTROLLED DRILLING & TAPPING MACHINE

The newest Layout Drilling Machine with Numerical Tape or Dial Control. Economically performs multiple operations for Single Piece Layout Work Short Run Production
The entire sequence of operations can be repeated time after time with no chance of operator error—minimizes operator attendance and skill.



FEATURES

- Flexibility in setting up a wide variety of operations.
- Quick conversion from one drilling job to another.
- Work from standard detailed drawings.
- Standard 1" 8 channel punched tape.
- Tape or Dial control.
- Infinitely variable spindle speeds 225-2700 rpm.
- Infinitely variable feeds 1 to 7 inches per minute.
- Nine different operations or tool changes at one setting.
- Foolproof tool rack (available) prevents use of incorrect tool.

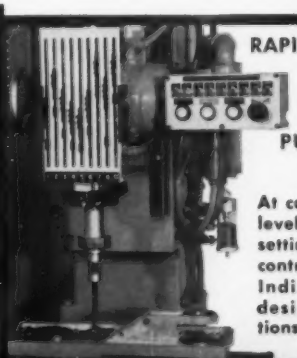
Featured at the National Machine Tool Exposition

* PATENTS PENDING

Write for Bulletin 200.

CONTROL CONSOLE

Operation Selector Switch and Lights for nine operations
Spindle Speed and Feed Setting Knobs and Tachometers.
Table Positioning Dials for two axiis.
Zero Offset Dials.



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At convenient eye level for precision setting and easy control.
Indicator Lights designate operations.

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A new concept in extremely rapid positioning table. Many exceptional features. Table Travel 14" x 20". 200"/per min.

Special Contract Job work can also be arranged with Edlund. Send Part, Blueprint and Requirements.

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EDLUND REPRESENTATIVES IN MAJOR CITIES

DEPENDABLE... predictable response to heat treatment every time

Send for Bulletin 102— "Helpful Heat-Treating Hints."

The full uniformity within each bar of Desegatized FM die steel and the consistent uniformity from lot to lot simplifies the heat treatment of your die components. Predictable hardnesses are readily attainable . . . distortion and size change are minimized . . . danger of cracking is lessened!

In free machining FM die steels, full uniformity is achieved through Latrobe's unique Desegatized process of manufacture. This process guarantees an even distribution of carbide particles, free machining alloy sulphides and other alloying elements . . . factors leading to improved machinability, greater toughness and improved wear resistance in addition to the optimum heat-treating characteristics.

Latrobe's 12% chromium FM die steels are available through district steel service centers near you. Grades include: Olympic FM (Type D-2) for long-run applications; GSN FM (Type D-3) non-deforming die steel; Cobalt Chrome FM (Type D-5) for extra resistance to galling and pickup.

Call your Latrobe representative today!

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LATROBE Metalmasters

LATROBE STEEL COMPANY

LATROBE, PENNSYLVANIA

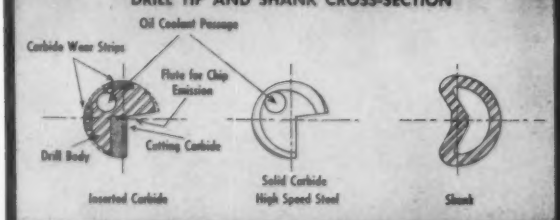
BRANCH OFFICES and STEEL SERVICE CENTERS: BOSTON • BUFFALO • CHICAGO CLEVELAND • DAYTON • DETROIT • HARTFORD • LOS ANGELES • MIAMI • MILWAUKEE NEW YORK • PHILADELPHIA • PITTSBURGH • SAN LEANDRO • TOLEDO

THIS DRILL ELIMINATES SECONDARY OPERATIONS

Just *one* pass with these high-speed steel or carbide-tipped gun drills produces an accurate, truly round, straight hole honed to mirror-bright finish. That's why you can drill small parts of all kinds — *faster, more accurately* and at *lower cost* with HI-STANDARD Gun Drills*.

Production parts that once had to be drilled individually can now be gang-nested and drilled through, producing holes identical in size, location and finish. Drilling of this kind is done on automatic indexing machines, lathes, horizontal and upright drilling machines, and similar equipment. Forced oil feed through the drill clears chips and cools cutting edge for faster drilling. No matter what the size or shape of your workpiece, drilling with HI-STANDARD Gun Drills is an

DRILL TIP AND SHANK CROSS-SECTION



outstanding time-and-money saver. Any material that can be *machined*, can be *gun-drilled*.

Gun drilling is one important way in which forward-thinking manufacturers are increasing production and cutting costs. To find out how your company can do the same, write for your Hi-Standard Engineering File 20 *today!*

*Also called "deep-hole drills"

Pioneers in the Design and Development of Gun Drills for more than 30 Years

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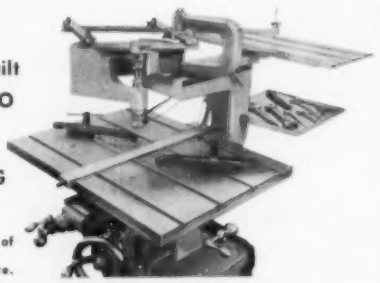
Use the LOW COST precision built PREIS-PANTO **2D-4** ENGRAVING MACHINE.

It does the work of larger machines, costing much more.



- *Pantograph is graduated with reductions from 1:1 to 100:1 and will reduce to any size to infinity.*
- *Pantograph and Spindle link joints equipped with precision ball bearings throughout.*
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BUILDS CONSISTENT CARBIDE PERFORMANCE

The Sandvik Coromant plant at Stockholm is one of the world's largest for the processing of tungsten carbide for tooling.

Sandvik's main U. S. plant in Fair Lawn, New Jersey has complete facilities for the manufacture of standard and special Coromant tooling.

Every step in the production of Coromant Carbide Tooling from the tungsten ore in the Sandvik controlled mine to the finished product is under strict quality control. Over 200 people are engaged exclusively in quality control of the production of Coromant carbides.

This is the major reason Sandvik Coromant carbides outperform competitive grades in many applications. It is your assurance of consistent quality performance by each Coromant grade from cutting edge to cutting edge – lot to lot.

FROM ORE TO FINISHED PRODUCT

A portion of the press room where the carbide is pressed into insert form prior to sintering.

Mining Coromant tungsten ore in one of Sandvik's mines at Yxsjö, Sweden.

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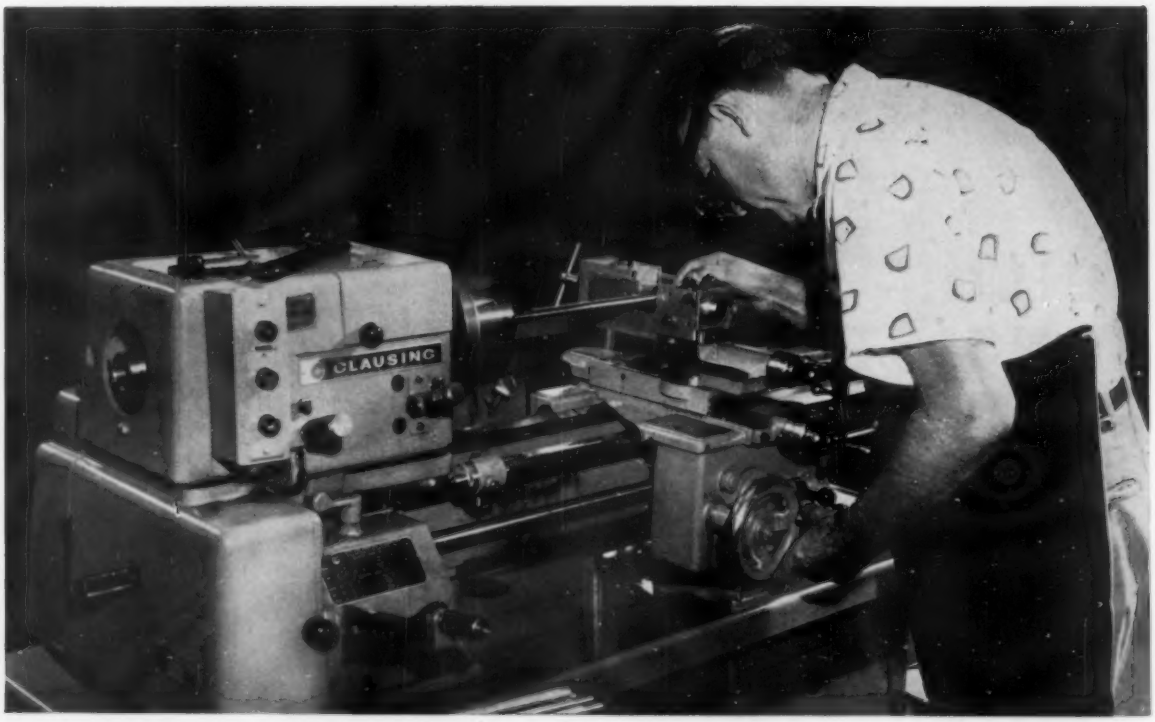
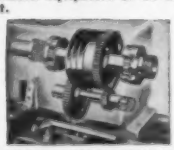
VISIT US AT BOOTH #104 — WESTERN TOOL SHOW — LOS ANGELES Nov. 14-18

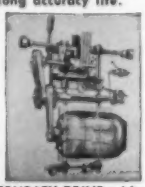


"For stamina, ease of operation, and ability to repeat to close tolerance Clausing 12¾" lathes lead their fields"

FLAME HARDENED BED WAYS — a long-service-life feature that is standard equipment at no extra cost.



TIMKEN "ZERO-PRECISION" TAPERED ROLLER BEARINGS assure precision performance and long accuracy life.



UNDERNEATH DRIVE with choice of variable speed countershaft or 10-speed countershaft, with clutch and brake optional.

This statement, by FREQUENCY STANDARDS of New Shrewsbury, New Jersey, is typical of user reports on CLAUSING 5400-Series lathes. And no wonder, no lathes at or near CLAUSING'S low prices give you so many QUALITY features. Here are just a few of them:

- SHAVED GEARS . . . an exclusive that assures greater accuracy.
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- BIG FORGED STEEL SPINDLE WITH HARDENED GROUND NOSE . . . 1⅜" bore . . . 1" collet capacity.
- TIMKEN "ZERO PRECISION" TAPERED ROLLER BEARINGS.
- CHOICE OF VARIABLE-SPEED OR 10-SPEED BALL BEARING COUNTERSHAFT . . . with clutch and brake optional.
- VERIFIED ACCURACY . . . factory test report accompanies each lathe.

Get *all* the facts and compare. When you have, we are confident you, too, will agree that "for stamina, ease of operation, ability to repeat to close tolerance and all around *value*, CLAUSING 5400-Series lathes lead their field by a wide margin." Write, today, for complete information.

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POWER-PACKED FEATURES PROTECTED BY POWER-GUARD CONSTRUCTION

1. Piston rod. Ground and polished alloy steel. Hard chrome-plated. **2.** Piston rod bearing. Replaceable cartridge-type. **3.** Piston packing adjusts automatically. V-block packing minimizes friction. **4.** Correctly stressed tie rods. **5.** Cushion bushings. Bronze, floating type. **6.** Ports rotated to any 90° position. **7.** Steel covers. Take minimum mounting space.

Send for catalog. Proof of SQUAREMASTER efficiency stated in these 20 pages. Write today.

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High speed dynamic balancing of gyros, rotors etc. to within 10 micro-inches (.000010-inch displacement) is easy with the Olsen-Rava Type S. Part is driven by a belt (as shown) or air at speeds to 36,000 rpm. The amount of unbalance is indicated on a meter, while a strobe light pin-points the "angle" on the rotor.

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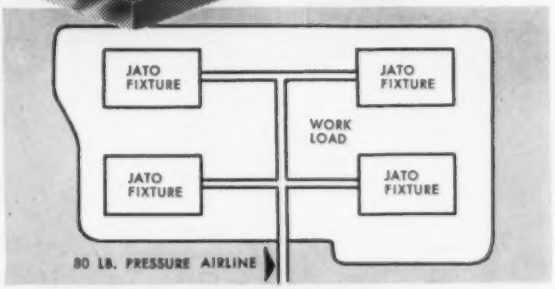

*UP TO 100 TONS

Work loads of cumbersome weight, odd sizes and shapes, can be moved fast and accurately over machine tables. One square inch of Jato area supports 25 pounds of load. Four 12" x 20" plates in series would permit an operator to position a 200,000 lb. casting with one hand using 80 lb. pressure on the air line.

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• Stilson Rubber Rollers permit fast, mar-proof handling of parts or products. These free wheeling rollers are available in a wide range of sizes and shapes. Write today for complete specifications.

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Stilson also manufactures Vacuum Cups, Venturi Blocks and Industrial Rubber Bumpers.

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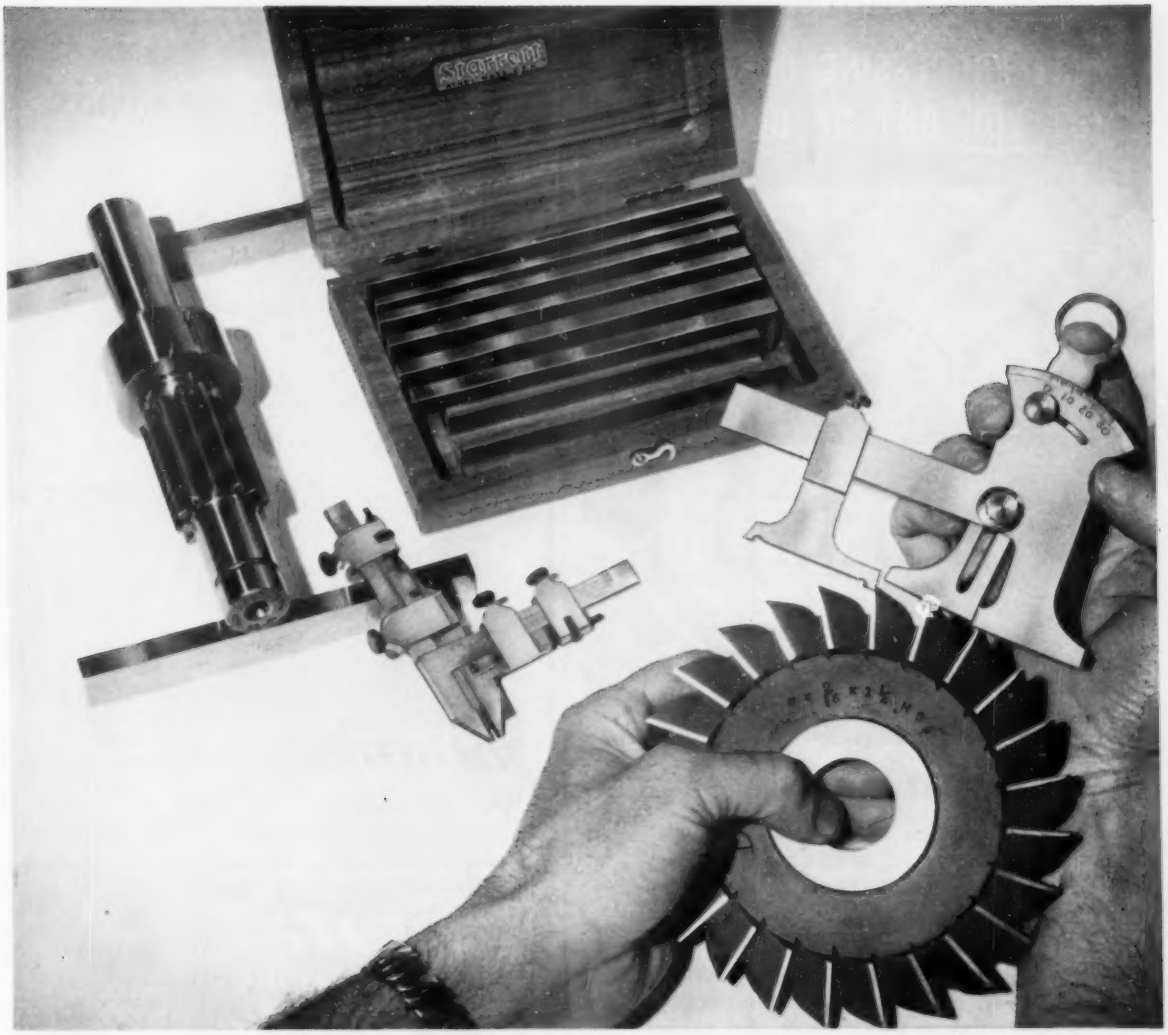

These STARRETT tools step up toolroom and shop efficiency

A small investment in these Starrett tools will pay big dividends in hours saved and better work.

ELIMINATE GUESSWORK or the need for elaborate gaging equipment in cutter grinding with Starrett No. 459 Cutter Clearance Gage. Tells at a glance when cutters have the right clearance angle, insures best cutting efficiency in all milling and planer-miller operations. Checks all types of cutters from 30″ dia. or more down to 2″ and smaller — also slitting cutters, broaches, saws.

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World's Greatest Toolmakers

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How efficient is your operation?

Engineers everywhere today are searching for areas to increase manufacturing efficiency and stem rising costs. Many are concentrating on heat processing and finding it to be a great offender in terms of waste.

Have you checked your operation recently? One of the easiest ways to do so is to call in a highly trained MOCO oven system engineer. He can point out many improvements in your operation and recommend the very best equipment to modernize your processing. Why not check with him today for more heat processing efficiency tomorrow!

YOU'LL WANT THESE BASIC OVEN FACTS IF YOU DO ANY OF THESE OPERATIONS . . .

MOLDING • FABRICATING • EXTRUDING • COATING • LAMINATING • RECLAIMING • MATERIAL PRODUCTION • RE-INFORCEMENT

This Fact Book by MOCO engineers on the basic operating principles of heat processing ovens should prove interesting. If you have specific questions, please write.

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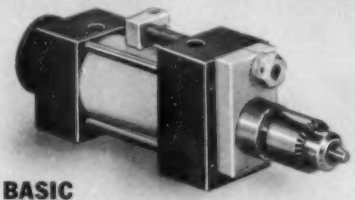

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(1/4", 3/8" capacity)
$89.40

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- Fits into any setup
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A Sinclair lubrication engineer recommended Sinclair's new DURO hydraulic oils with oxidation, rust and foam inhibitors. Result: outstanding performance, with "rejects" cut to minimum.

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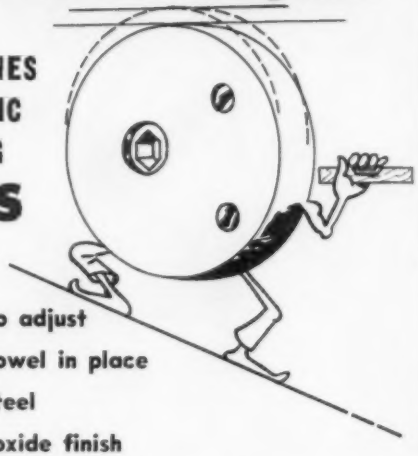
ECCENTRIC
LEVELING
LUGS



☆ Easy to adjust
☆ Just dowel in place
☆ 1113 Steel
☆ Black oxide finish

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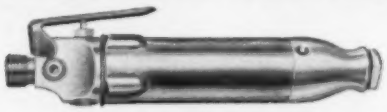

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Light Weight—15 Oz.

SPEED 50,000 R.P.M. . . . OVERALL LENGTH 6½". This husky little grinder, when used with Carbide Burs, Rotary Files and Mounted Wheels, produces astonishing results on real production work. It continues to do so with the minimum of time out of service. AIR CONTROL LEVER for starting and stopping flexible and efficient. ADJUSTING SCREW regulates speed for varying air pressure. BEARINGS special greased. Spindle accommodates mandrels ¼" dia. A collet ¼" O.D. ⅛" or 3/16" I.D. available for use in spindle.

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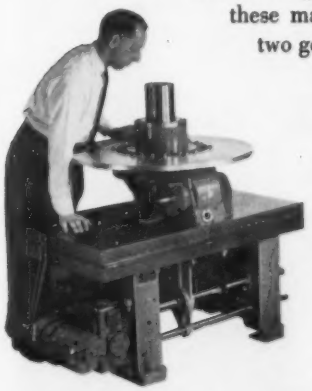

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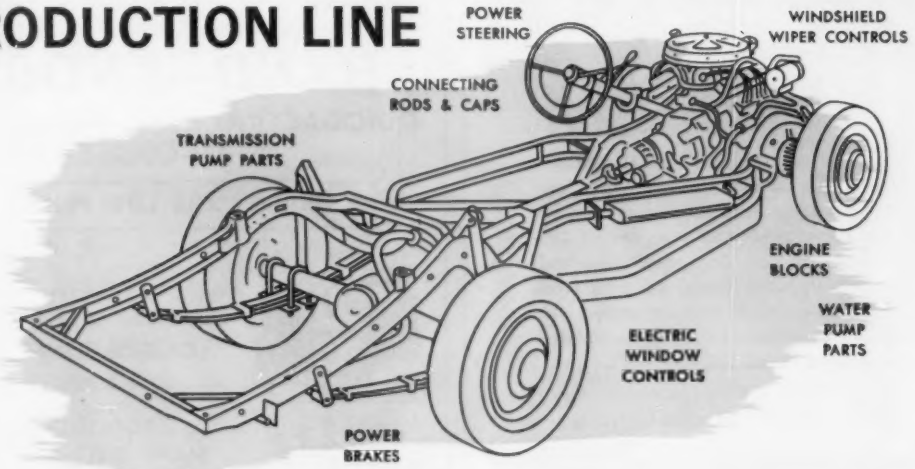

There are many money-saving reasons why machine lapping with the Lapmaster has become an important, and in many cases a necessary, operation in the production of automobile parts, from large engine blocks to small water pump impellers. For instance:

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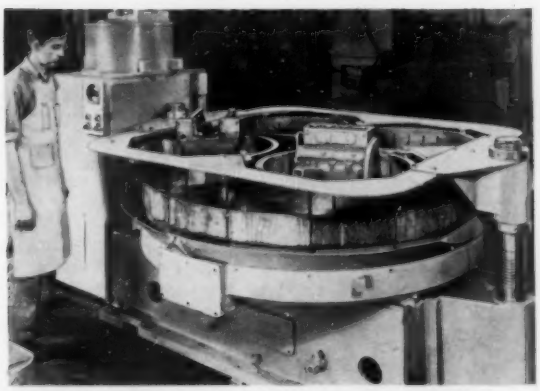

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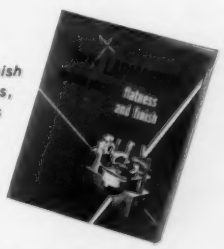

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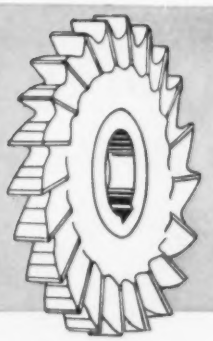

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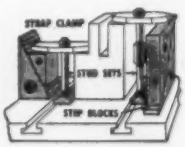

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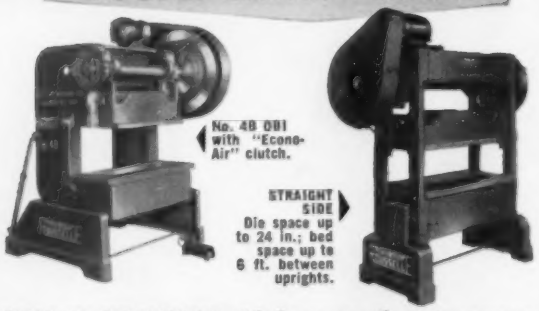

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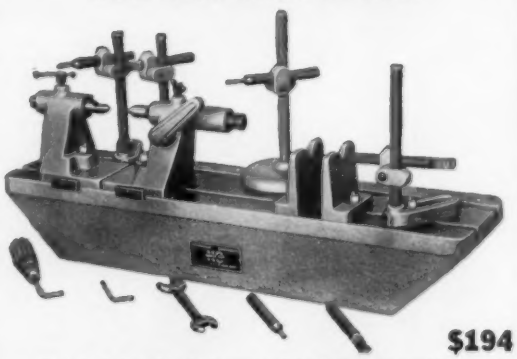

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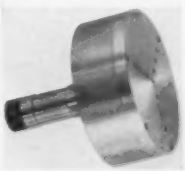

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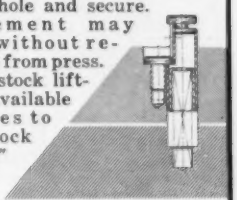

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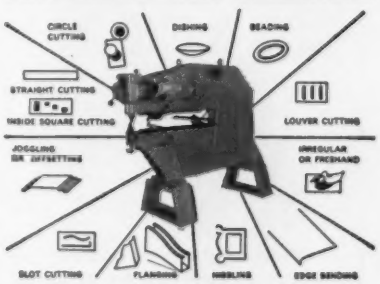

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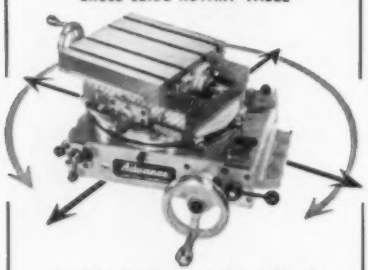

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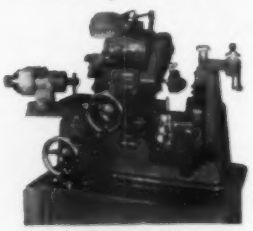

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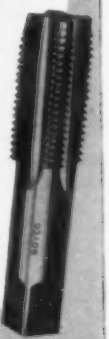

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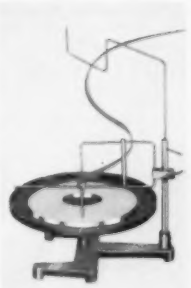

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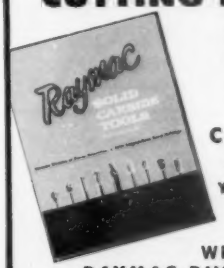

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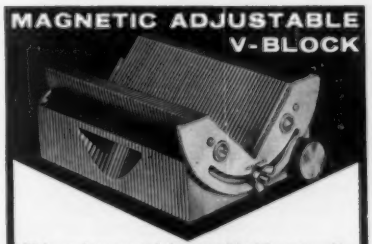

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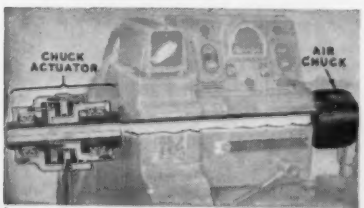

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Published March 15, 1961

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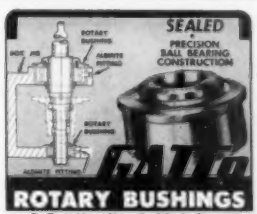

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LOOKING AHEAD

By T. W. Black
Senior Associate Editor

Can an ultrasonic treatment improve the life of steel cutting tools, dies and wear parts? Experience with treated tools at a major automotive plant indicates that it can. A gear shaper cutter, which formerly produced from 120 to 125 pieces per grind, produced over 250 pieces per ground after ultrasonic treatment.

The tools are treated after being hardened. Treatment does not affect size or hardness but does produce a small, hair like burr on cutting edges. This burr must be ground off.

Ultrasonic treatment apparently decreases the brittleness of metal, reducing chipping even in extremely hard tools. Productive Tool Service, Inc., Cleveland, Ohio, is now treating tools and wear parts on a production basis.

✓ ✓ ✓

The month of September saw some outstanding advances in the development of high-temperature.

The National Bureau of Standards has announced a method for producing nickel-aluminum coatings capable of protecting metals from oxidation at temperatures up to 1832 F. Nickel is plated over the base metal and aluminum is then plated over nickel at 1292 F.

Ling-Temco Electronics, Inc. is welding and machining a new columbian (niobium) alloy, F-48. Columbium retains usable structural properties at 2500 F, as compared to 1500 F, for steel and 1990 F for nickel alloys.

✓ ✓ ✓

High melting-point materials may be produced with the aid of a high-energy arc heater devised by Westinghouse Electric Corp. Potentially, the machine can supply a stream of gas at temperatures as high as 20,000 F and pressures as great as 15,000 psi.

The arc heater has immediate application in a wind tunnel for missile testing. Also, it holds promise as a chemical synthesizer that will supply the high temperatures necessary for inducing difficult chemical reactions.

The unit's potentialities as a furnace may make a number of refractory metals available in ingot form for the first time. Normally used in powder form, such metals as tungsten are difficult to process because of their high melting points.

✓ ✓ ✓

The cyclical low point of the machine tool industry has been reached, according to The Value Line Investment Survey. During the next nine months, orders for new machine tools should rise 40 percent. The Machine Tool Exposition is credited for furnishing the stimulus for this rise.

Cost-Cutting—

A SIMPLE MATTER OF SELECTION

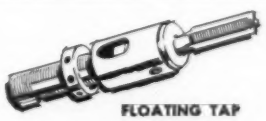
59-15

COUNTERBORE SETS

INVERTED SPOT FACERS

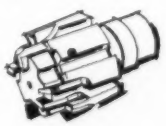
COUNTERBORES—

COUNTER SINKS, HOLDERS, PILOTS

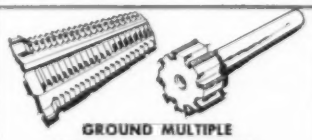


FLOATING TAP DRIVERS

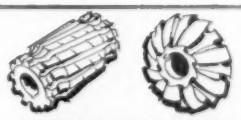
INSERTED BLADE FACE MILLS



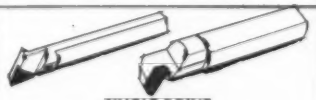
MULTIPLE DIAMETER BORING CUTTERS



GROUND MULTIPLE THREAD MILLING CUTTERS



GROUND AND UNGROUND FORM-RELIEVED CUTTERS



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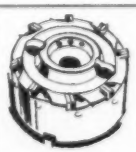
MULTIPLE STEP BORE REAMERS



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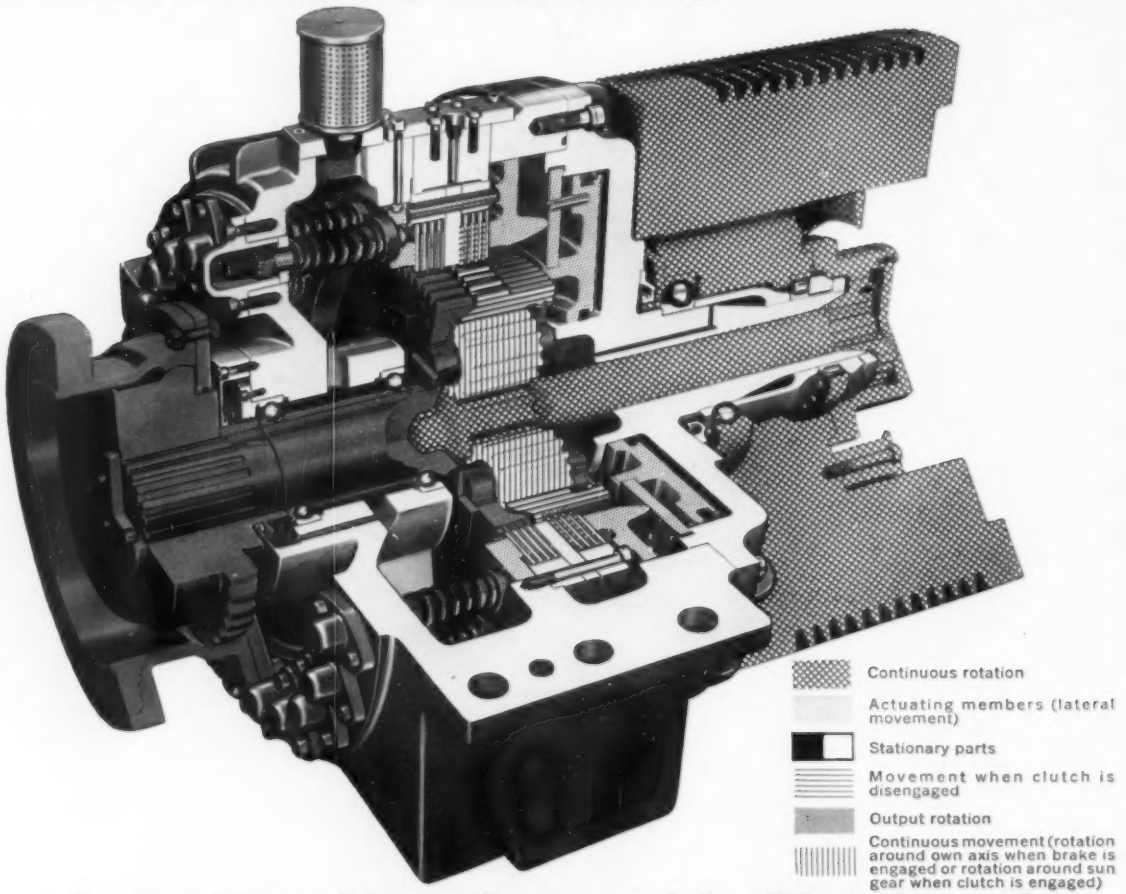
Announcing the Clearing Torc-Pac 40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